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POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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JOURNAL OF ELECTRICITY
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VOLUME XXIV. SAN FRANCISCO, JANUARY 1, 1910. NUMBER 1

ELECTRICAL EQUIPMENT OF AN ARMORED CRUISER

BY L. ST. D. ROYLANCE.

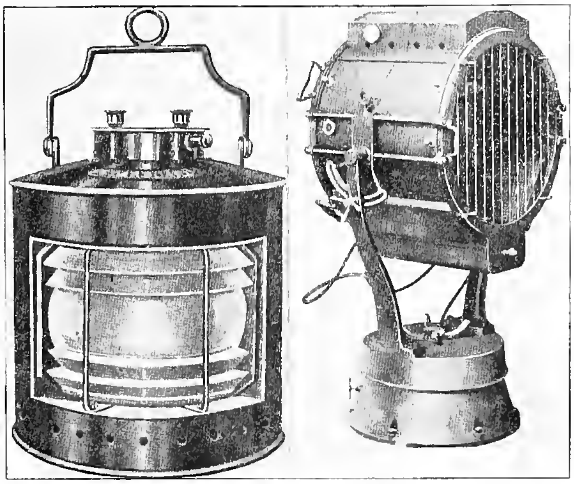
Very little if anything has been written regarding the character and requirements of an electrical plant on board a man-of-war. It is evidently a subject with which but few engineers are familiar, and those who are, have no doubt considered it of not enough importance to mention in the various engineering discussions.

U. S. Armored Cruiser "California."

The writer will, therefore, endeavor to give in as brief manner possible, a description of the electrical installation on board the U. S. S. California, as well as the requirements exacted by the U. S. Navy. This armored cruiser was constructed by the Union Iron Works of San Francisco.

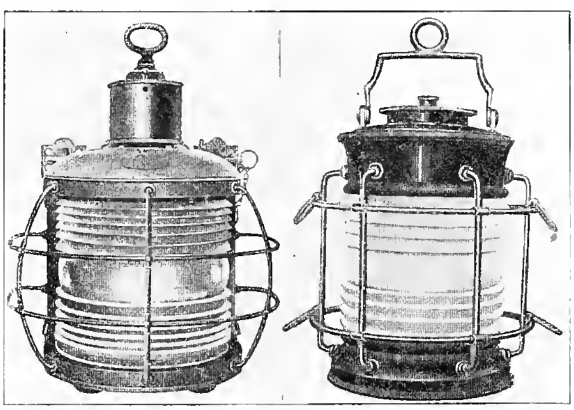
The installation consists in general of three 100 k. w. and four 50 k. w., d. c., generating sets, all of 125 volts pressure at the terminals; and a switchboard of sufficient capacity for the proper distribution of the electric current for lighting, power, etc. The lighting plant contains about 1400 branches and outlets consisting of the following fixtures and appurtenances; for rigging, etc., above main deck; top lights, Admiral peak lights, masthead lights, side lights, towing lights, double truck lights, and instrument lights. The lighting fixtures for general illumination throughout the ship are designated as follows: Single and double brackets, desk lights, ceiling fixtures Nos. 1 and 3, bulkhead fixtures, bunker fixtures, steam-tight globes, deck lanterns, battle lanterns, signal lanterns, magazine lanterns, diving lanterns, cargo reflectors, water-tight and non-water-tight portables and arc lamps which are installed in the fire and engine rooms; and 1/12 and

1/6 h. p. fans, and 1/4 h. p. portable ventilating sets, which are also operated on the lighting circuits. There are also six 30-in. searchlights and two night signal sets.



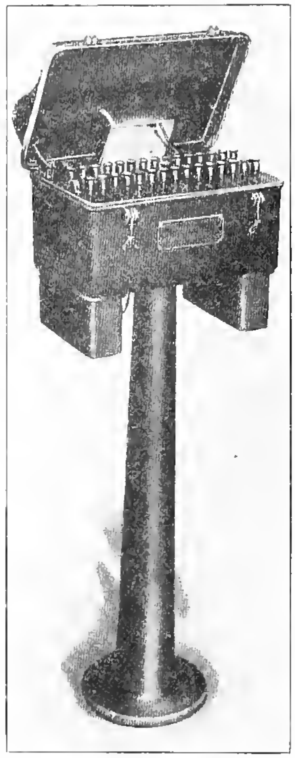
Side Light, Searchlight.

The Admiral peak lights and top lights are located at the mainmast upper top, the masthead and towing lights are located at the foremast upper and lower tops respectively, the side lights are red and green and are located on the port and starboard sides of the flying bridge, and the double truck lights are fitted to the tops of the foremast and mainmast, having two lights in each and fitted with red and white lenses; they are used for signaling and are controlled from the flying bridge by a double truck light controller. The night signal sets are installed, one on each mast, and are suspended from a specially constructed ladder which carries the set of four double lanterns, each fitted with a double lense, one of red and the other of clear glass. The lanterns are connected by means of cables to a



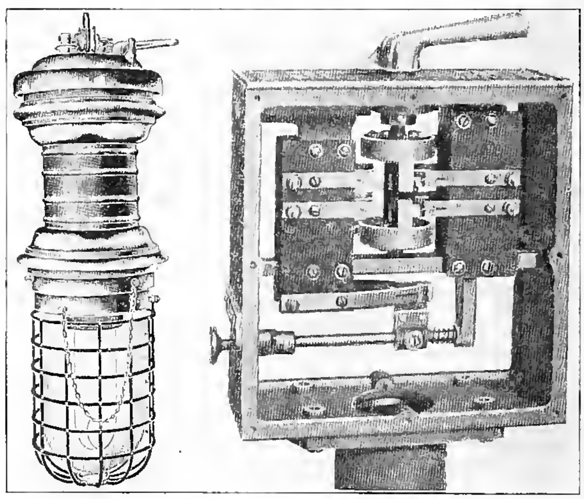
Masthead Light. Signal Lantern.

keyboard for each set. The keyboard consists of a water-tight box containing the mechanism for connecting the various combinations; the mechanism consists of a plurality of quick break switches operated by depressing the different plungers or keys projecting through the keyboard; an interlocking arrangement is provided which prevents depressing more than one key at a time; a pulsator key is also provided for pulsating the lamps in the upper lantern. These keyboards are located one each on the after upper bridge and the forward flying bridge.



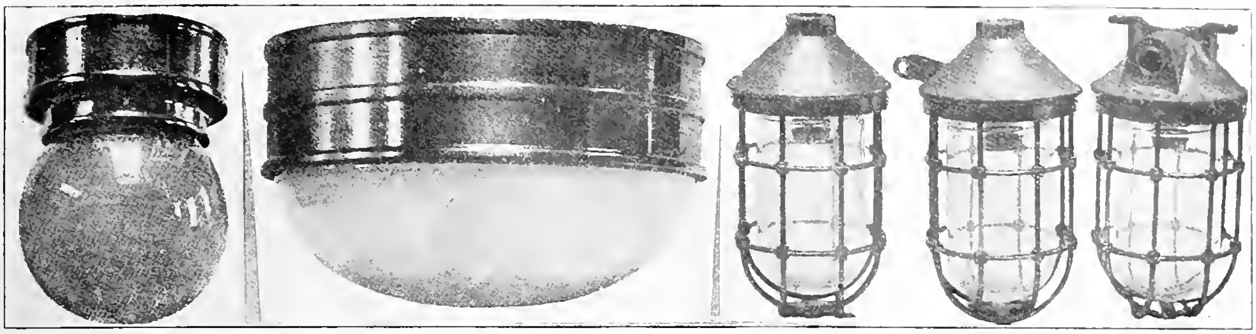
Night Signal Set Keyboard.

The six searchlights are located on specially constructed platforms, three each at the foremast and



Arc Lamp and Double Truck Light Controller.

mainmast; they are so arranged that it is possible to cover any portion of the surface of the water with a beam of light. The searchlight currents are regulated by means of rheostats located at the searchlight switchboard, and the best results are obtained with a current of from 75 to 85 amperes at 48 to 55 volts pressure.



Ceiling Fixture No. 1. Ceiling Fixture No. 3. Steam Tight Globes. Drop Light. Bulkhead Fixture. Deck Fixture.

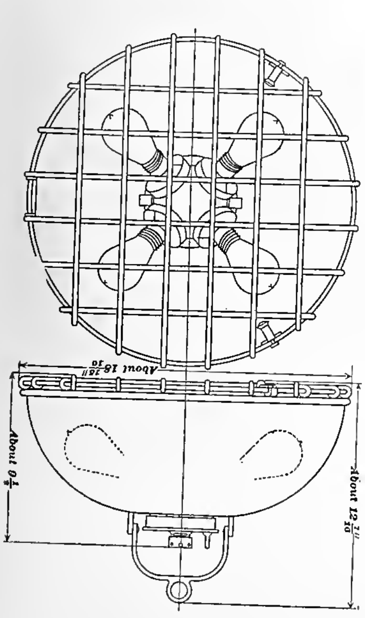
Lighting System.

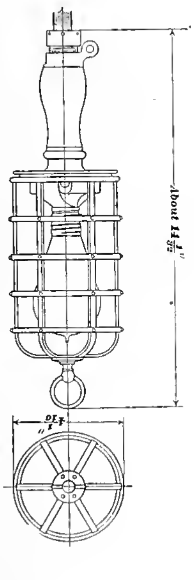
The lighting system is arranged upon two circuits called the lighting and battle circuits. There are about 20 battle feeders feeding about 64 battle mains and 8 lighting feeders feeding about 18 lighting mains; making a total of 28 feeders and 82 battle and lighting mains throughout the ship.

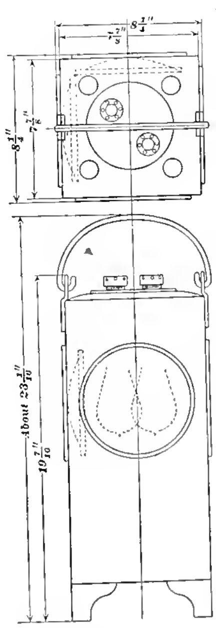
The lighting circuits are for general illumination of the decks, passages and officers' and crew's quarters above the protective deck (a heavy steel turtle-back-shaped deck covering the most vital parts of the ship; the dynamo rooms, fire and engine rooms, steering gear and magazines). The battle circuits take in all decks above and below the protective deck and include the signal circuits. The battle circuits or mains are staggered, that is, a battle feeder feeds several mains in various parts of the ship, so that during action, should any feeder fail, no part of the ship will be in total darkness.

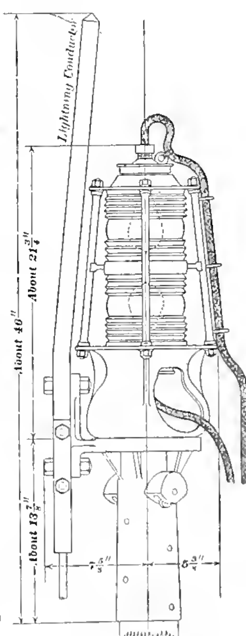
On the battle circuits no fixed lights are installed above the berth deck or outside of the armor belt, all being of the battle lantern type, or so located that no naked lights may be seen from the outside.

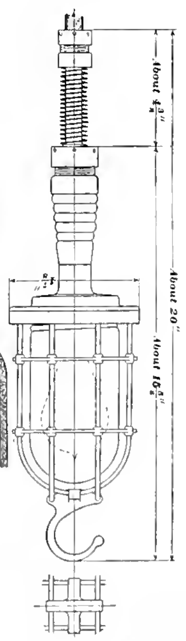
The single and double brackets are on the lighting circuits and are located in the wardroom officer's quarters. The desk lights and fans are located in the ward room, warrant and junior officers' quarters. The ceiling fixtures No. 1 are neat silver plated fixtures with frosted globes, containing 16 c. p. incandescent lamps and are used in the ward room officers' quarters. The No. 3 ceiling fixtures are much larger, having large, shallow, dome-shaped frosted globes and are used in the sick bay or hospital of the ship. The bunker fixtures are permanent fixtures which light only the coal bunkers and are on battle mains only. The magazine lanterns are portable to a certain extent, and contain two 16 c. p. incandescent lamps, each separately fused. The lamps are made permanent by being placed in fixed magazine light boxes. The bulkhead fixtures and steam-tight globes are practically the same, differing only in the method of installing. The steam-tight globe when suspended from the end of a conduit is called a drop fixture, when secured to a deck it is a deck fixture and when secured to a bulkhead is a bulkhead fixture; the only difference being in the position of the feet and conduit inlet. They are fitted with a helical spring socket, contain a 16 c. p. incandescent lamp which is enclosed by a steam-tight clear glass





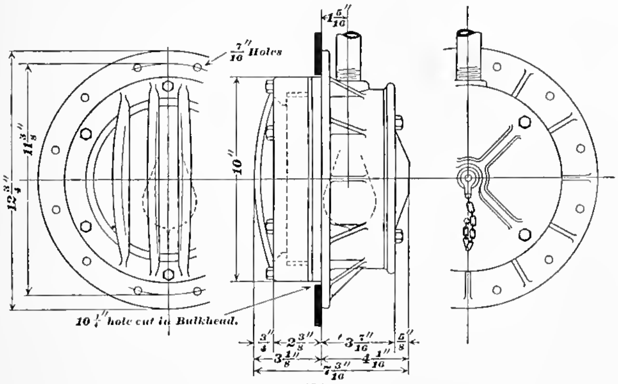






Cargo Reflector. Non-Watertight Portable. Magazine Lantern. Double Truck Light. Watertight Portable.

globe which is protected by a heavy brass guard. The battle, deck and signal lanterns are almost identical, except for the battle lantern shutter, which is capable of shutting off all light. The deck lights are without shutters and the signal lanterns are the same excepting that the lenses are red, white, or green. The cargo reflectors are a special type of lamp cluster with a



Bunker Fixture

protected reflector, and the non-water-tight and water-tight portables are of a special type adopted by the U. S. Navy, and are used throughout the ship. The instrument lights are contained within the instrument which they illuminate, such as the binnacle, pelorus, etc.

Interior Communication System.

The interior communication system embodies all means of transmission of signals and messages and consist of the following systems:

1. Mechanical gongs.
2. Mechanical engine telegraphs.
3. Voice tubes.
4. Electric call bells, push buttons and annunciators.
5. Telephones.
6. Fire alarms.
7. Warning signals.
8. General alarm gongs.
9. Electric engine telegraphs.
10. Steering telegraphs.
11. Engine revolution and direction indicators.
12. Helm angle indicators.
13. Automatic electric steam whistle operator.
14. Electric log.
15. Battle order, range order and powder division instruments.
16. Long arm water-tight door indicators.

1. The mechanical gongs are used where a limited number of orders are to be transmitted. They are located in the main engine rooms, anchor windlass, at the foot of all chain ammunition hoists and at the top and bottom of each ash hoist.

2. The mechanical engine telegraphs are of the Navy Standard type and are located on and in the pilot house and in the conning tower, one for each engine. They connect with indicators in each engine room. The telegraphs are so arranged that those above the conning tower can be cut out by means of cut-out switches should they be disarranged or shot away in action. Likewise the telegraphs in the conning tower can be disconnected from the main lead, and are kept normally disconnected to reduce friction.

3. The voice tubes are installed between important stations where conversation is necessary. They are of solid hard-drawn brass 2 in. in external diameter, except in the conning tower where they are larger. At stations exposed to the weather, a solid hinged cover is fitted to the mouthpiece, making it water-tight. The whistles are in the wall of the mouthpiece. The voice tube terminals are mounted on water-tight boxes in places exposed to the weather and dampness, and on brass plates mounted on a hollow wooden base where not exposed. On these boxes or bases the mouthpiece and electrical calling apparatus are mounted, with the connections inside.

Where voice tubes lead from more than one station, a special form of three-way valve is installed, by means of which either station may be cut out or connected from the voice tube. All voice tubes have return calls except those for the ammunition hoists and between the pilot house top and pilot house. Voice tubes are installed under the main deck, except those from the conning tower to engine rooms, steering room and dynamo room, which are led through the armored tube. (The armored tube is a very heavy specially prepared nickel steel tube connecting the dynamo room with the conning tower, and through which all important circuits are run for protection when in action.)

4. The electric call bells, push buttons and annunciators embody the admiral and captain's calls, ward room officers' calls, junior officers' and boat hour gongs, warrant officers' calls, telephone ringing and all voice pipe calls.

Call bells and buzzers without reply are installed to call servants or subordinates. Annunciators are used where more than one call comes to a station, the non-water-tight type with buzzers being installed in pantries. At all other stations the water-tight annunciators with 3-in. water-tight bells are installed. The push buttons and buzzers are of the water-tight and non-water-tight types, and all bells are of the water-tight type.

Four or more 6-in. vibrating gongs are installed in various places about the ship to announce boat hours while the ship is in port. The push button for operating these is located on the quarter deck.

5. The telephone system is what is known as the Holtzer-Cabot Navy type system; consisting of a specially designed, water-tight telephone station complete with call bells and special Navy type, central energy switchboard with talking and calling motor-generators and all necessary apparatus for 42 telephones; 18 of which are water-tight and 24 non-water-tight. They are located throughout the ship.

The special features of the telephone system are the water-tight, cordless instruments and switchboard, double receiver and sound insulated transmitter. The cordless switchboard is arranged with extra large target signals and a multiple connection feature is included by which any one station can, if necessary, converse with five other stations simultaneously.

The system is so arranged that any station can be put into immediate connection with any other station

in the system by means of an attendant at the central switchboard. Current for signaling and talking is centralized at the switchboard. The call from the stations to the central switchboard is entirely automatic and the only movement necessary by the party using the telephone is to place one or both receivers to his ear, this movement transmitting the necessary signals and placing the calling station in connection with the switchboard operator. The station has also a shore line connection by means of which, the ship may be placed in communication with shore stations while in port. The telephone ringing circuit requires about 6.6 volts and the talking circuit about 24 volts. The currents for ringing and talking are taken from the central distribution switchboard, which is supplied by either battery, motor-generator or dynamotor.

6. The fire alarm system consists of about 71 mechanical thermostats installed in storerooms, coal bunkers and magazines. They connect with an annunciator placed at the captain orderly's station near the captain's quarters. The thermostats are set to operate at about 200 degrees F. for storerooms and coal bunkers, and about 100 degrees F. for magazines.

7. The warning signals consist of about 27 electric solenoid whistles located near the automatic closing doors and hatches. They emit from 10 to 15 shrill whistle blasts at an intermission of a few seconds each, before the closing of the water-tight doors. They are operated by two automatic contact makers located near the automatic water-tight door emergency switches; one in the pilot house and one on the quarter deck.

8. The general alarm system consists of four automatic clock switches or contact makers, located one each in the pilot house, conning tower, captain's stateroom and executive officer's stateroom, operating about thirty-two 12-in. single stroke electric gongs throughout the ship. They are used as general alarms for rousing the crew.

9. There is one complete set of electric engine telegraphs for each main engine, each set consisting of a combined transmitter and receiver on the bridge, in the pilot house and in the conning tower. These three instruments are all connected in parallel to a combined transmitting and receiving instrument in the engine room, the complete set of instruments thus comprising four. All instruments are similar in construction, except that an attention bell is installed in connection with the receivers in the engine rooms. The operation of these telegraphs is the same as that described for the steering telegraphs which follows.

10. The construction of the electrical steering telegraphs does not differ materially from that of the engine telegraphs; the interior mechanism being identical in each; a difference exists in the dials only. The system consists of five instruments; on the bridge, in the pilot house, conning tower, central station and steering-wheel room. All of these instruments are combined transmitters and receivers, being connected in a similar manner to the engine telegraphs. As the receivers are connected in parallel with the transmitter contacts, the lamps in the receivers will light when either transmitter arm is moved from the off position. For instance suppose the order "5 degrees port" should be transmitted from the bridge. The lamps behind the discs marked with this order in the receivers in the central station and steering room will light simultaneously and the attention bell will ring. The man whose duty it is to receive the orders will immediately move the pointer on his instrument to the lighted disc, lighting the lamps behind the corresponding discs in the conning tower, pilot house and on the bridge, thus signifying to the person who transmitted the order in the first place that it has been understood and carried into effect.

11. The revolution and direction indicators are on the flying bridge, in the pilot house and conning tower, one for each engine. They are mounted on the engine telegraph transmitters. The indicator consists of a circular water-tight case with plate glass face. The dial is of white porcelain and is marked "ahead" and "astern" just over two small pointers. The pointers are operated by electro-magnets which are controlled by two eccentrically geared contact makers fitted to the main engine shafts. The pointers pulsate at each revolution, and register ahead or astern only when the attendant presses a water-tight push button which controls the lighting current for illuminating the dial and about 6 volt current for operating the pointers.

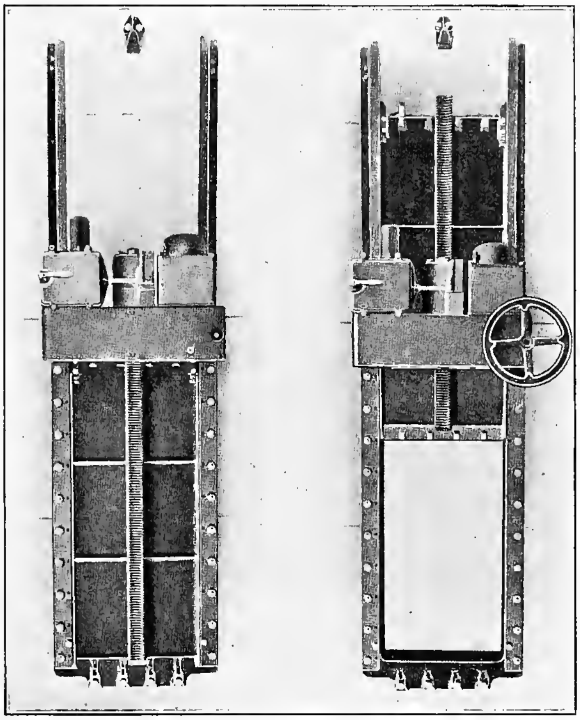
12. There are six instruments in the helm angle indicator system; one transmitter and five indicators. The transmitter is located in the steering engine room, the indicators in the following locations, viz.: on the bridge, in the pilot house, conning tower, central station and steering-wheel room. The transmitter is mounted over the steering gear and is operated from a sheave on the rudder head. The indicators are somewhat similar to the engine and steering telegraph indicators, and register the position of the helm or rudder . The current for operating same is taken from a battle lighting circuit.

13. The automatic steam whistle operator consists of an automatic and at will operating switch; it contains a clock and is located in the pilot house. It can be arranged to automatically blow an electromagnetically operated steam whistle for six seconds per minute, etc., and is used in foggy weather and also for signaling by hand.

14. The electric log consists of two electric log transmitters, telltale indicator and an electric log indicator. The transmitters are located on the port and starboard after sides of the ship near which is located the telltale. They connect with and operate the log indicator in the pilot house. By means of the telltale, those in charge can tell at a glance whether the transmitters are working properly. The object of this appliance is to give in the pilot house, without recourse to passing the word along the deck, the reading of the log and also a continuous totalized record of the knots traveled.

15. The battery control is an elaborate system. In general it enables the commanding officer from a central station to communicate battle orders, ranges and deflections to all parts of the ship, by means of transmitters, indicators, etc. The operating current is taken from a special battery control switchboard in the central station which is fed from the battle lighting circuits. (The battery control system has since been superseded by a new system of battery control.)

16. There are about thirty electrically operated water-tight doors and hatches. They are controlled by an automatic emergency switch located in the pilot house; in connection with this switch is an indicator. As each door or hatch is closed it operates an automatic switch which connects a 5 c. p. lamp in the indicator at the emergency switch. The circuit for lighting these lamps is completed through a switch operated by a button through the cover of the indicator. When this button is pressed the lights corresponding to all the closed doors and hatches will glow, and through the numbered translucent discs in the cover the operator is able to determine exactly which doors and hatches have responded to the emergency station.



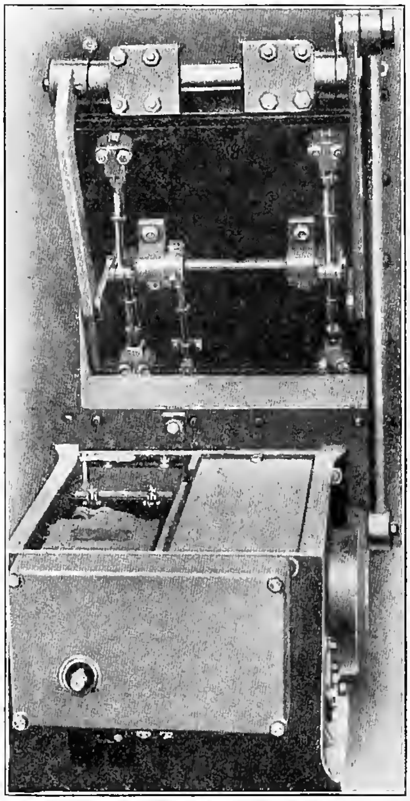
Watertight Door.

Power System.

The electric power system consists of about 43 power feeders supplying about 100 power mains, which in turn supply current for about 140 motors; made up of water-tight door and hatch motors, chain ammunition hoists, turret ammunition hoists and rammers, exhaust and blower ventilation motors, gun elevating and turret turning motors, fresh water pump, dough mixer and dishwasher motors; laundry and machine shop motors; air-compressor motors, electric deck winch motors, boat crane motors, and motor-generating sets.

There are about 30 water-tight doors and hatches. They are located between the coal bunkers and firerooms and water-tight compartments below the protective deck and are operated by motors of a special type and design rated at 1 h. p. each.

The chain ammunition hoist motors number about 34. They were specially built by the Union Iron Works. The chain hoists are used for raising ammunition from the ammunition handling rooms and passages to the gun decks for distribution to the guns. They are of the endless chain type, consisting of two endless chains running over sprockets at the top and bottom of the hoist trunks. The two chains are connected at intervals by carriages. The up-going and down-going chains are separated by means of partitions in the trunks. The hoists have feeding tables at the bottom of the hoist trunks, so arranged that as the ammunition is fed it will be carried up the trunks on the carriages and delivered on the deck at the upper ends. The hoists are driven by 2.5 h. p. shunt motors, through friction drives which will permit the motors



Watertight Hatch.

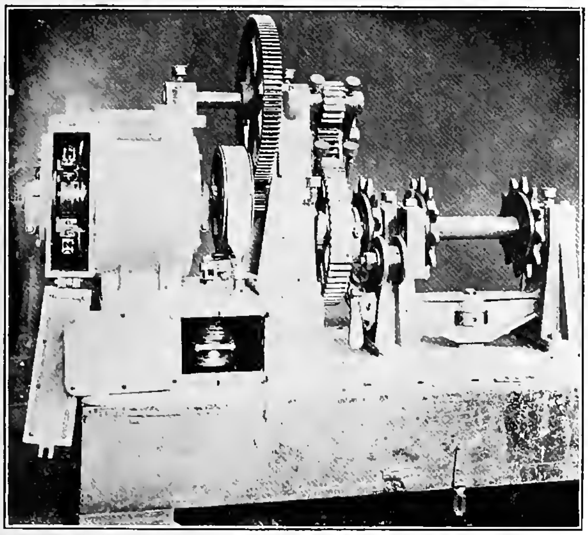
to revolve without damage should the ammunition for any reason jam in the hoist trunks. The motors are reversible and are controlled by specially constructed Ward-Leonard starting boxes and reversing switches, in the construction of which sparking is reduced to a minimum, as it is imperative that there shall be no sparks near ammunition.

There are four turret carriage ammunition hoist motors installed, two in each turret; one for each gun. They are General Electric 4-pole, shunt wound, have an output of 11 h. p. each and require at full load about 80 amperes at 125 volts, and are operated by the Day control system. The Day system of motor control consists essentially of the introduction of a variable resistance in the motor armature circuit. In lowering, the motor is operated as a generator, being run by the weight of the car. The speed is regulated by the amount of the resistance introduced in the armature circuit. The controller is of the drum type and provides for the operation of an electro-magnetic brake, for introducing steps of resistance for hoisting and for lowering and for short-circuiting the armature on the

off position and on the first lowering position.

When the car is hoisted with ammunition, it is stopped and locked in the proper position for ramming the projectile and powder into the breech of the gun. This is accomplished by means of a telescopic rammer operated by an electric motor, controlled by a drum controller. There are four of these rammers; two in each turret, one for each gun. The motors are series wound, of 3.5 h. p., and drive the rammers through a slip-clutch which relieves the motor when the rammer has reached the limit of its travel. The current required at full load is about 26 amperes at 125 volts. (The ammunition hoists and rammers described above have since been superseded by a new system of ammunition control.)

The turret gun elevating equipment is operated on the Ward Leonard system of motor control. The control is similar to that of the turret turning system. A motor-generator set is used instead of one of the steam generating sets. There are four motor-generating sets and four elevating motors installed; two motor-generating sets and two motors for each turret; one generating set and one motor for each gun respectively. The motor-generators are General Electric, have an output of 4.7 h. p. and require at full load about 39 amperes at 125 volts. The motors are also of the General Electric Co. make, have an output of 3½ h. p. and require at full load about 27 amperes at 125 volts. The controller or controlling rheostat is located under the gun pointer's sighting hood, secured to a bracket which is a part of the gun-sight bracket. The arrangement of the controller is to control the speed of the motor by the usual process of varying the potential of the generator field, but reversal is accomplished by reversing the direction of the current in the generator field, the connections of the elevating motor terminals and generator terminals remaining fixed and direct.

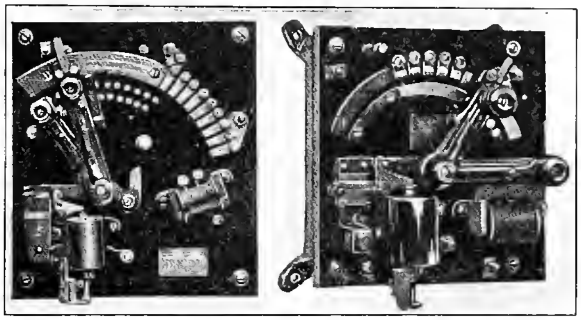


Chain Ammunition Hoist.

The electrical apparatus for turret turning consists in general of two 15 h. p. shunt wound motors located right and left in the base of the turret on a level with the gun deck; a motor board, installed in the same compartment; a controller, rheostat, circuit breaker and ammeter located in and turning with the turret, and one of the ship's generators. The motors are of the General Electric Co. shunt wound 125 volt enclosed type, rated at 15 h. p. each. They take a full load current in the armature of 105 amperes at 400 r. p. m., with 2.5 amperes in the fields. The system of control is a combined Ward-Leonard and motor-field weakening control.

The Ward-Leonard system of turret control is capable of a wide range of speed, with very fine increments of variation. The turret turning speed is from ¼ degree per minute minimum to 100 degrees per minute maximum, between which there are about 70 variations and the turret can be started from rest and brought to full speed in 10 seconds and can be stopped in five seconds' time.

The operation of the turret turning system is as follows: The armature of a separately excited compound wound generator with its series field short-circuited by a low resistance shunt, allowing only a small portion of the armature current to flow through it, is directly connected with the armatures of the two shunt wound separately excited motors arranged in series. The shunt field of the generator is supplied from the power mains, and the line voltage is varied up to a certain point by the controller. The shunt fields of motors are also supplied from the power mains, and the line voltage is varied by the same controller after it has ceased to affect the generator field.



Ward-Leonard Starting Boxes for Blower and Hoist.

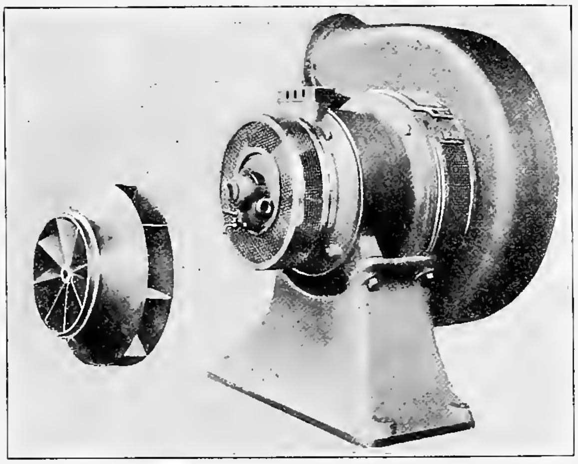
In the off position of the controller, and supposing switches to be closed, there is a weak current through the generator field, and line voltage of the motor fields. As the controller in the turret is turned by the operator to the first running position the voltage of motor fields remains as it was, but the resistance in circuit with the field of the generator is decreased, causing low voltage in the turret turning armatures and the slowest speed of rotation of the turret. Successive steps on the controller gradually cut resistance out of the generator field which increases the voltage at the turning motors and the speed of rotation of the turret. Except with controller in "off" position, the turning motor armatures are in series with the generator full line voltage in the fields and the speed of rotation of the turret has increased from minimum to one-half maximum. Normal voltage is now being impressed on the two motor armatures, and as they are in series, each takes one-half the line voltage.

Further operation of the controller cuts resistance

in series with the turning motor fields, causing further increase in speed of rotation of the turrets up to the maximum.

(1)	(2)	(3)
Normal motor fields, low impressed armature voltage.	Normal motor fields, normal impressed armature voltage.	Weakened motor fields normal impressed armature voltage.

In case of failure of one of the turning motors, it can be thrown out of circuit by opening its armature and field switch on panel in barbette. The armature switch must be seated in the circuit closing clips provided. When the field switch of a motor is opened the short-circuiting clips throw the other motor field directly across the line which cuts out the field weakening control, and the system is now ready for operation on the Ward-Leonard system using one motor only. Every controller position will now give approximately double the speed that was given when using two motors, because double the line voltage is being impressed on the single motor armature and when the controller is turned to that position at which normal voltage is impressed on the armature of the turning motor, any further movement of the controller will cause no change in speed.



Union Iron Works Ventilating Set.

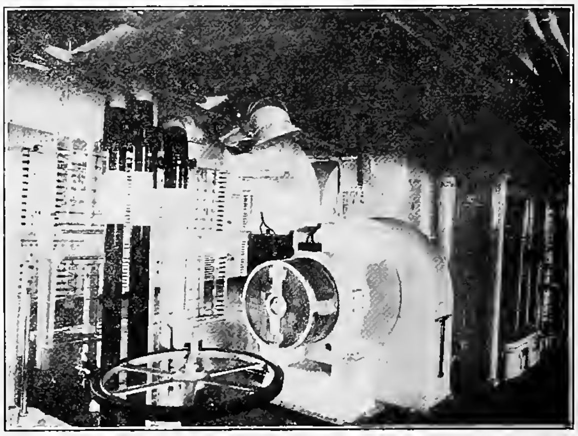
There are about 28 ventilating sets, the motors of which range from .6 to 16 h. p. each. The motors are shunt wound, capable of a wide range of speed variation by means of field control. They are equipped with Ward-Leonard field regulation motor starters.

The artificial ventilation of the ship is by means of electrically operated exhaust and pressure blowers. The motors are directly connected to the fan runners and both motor and fan are mounted on a base common to both. In the ventilation system air is supplied to the different compartments under a pressure of from 2 to 6 lbs. per sq. ft. Each compartment has its own system and such compartments as the lower dynamo room, etc., the foul and hot air is carried away by exhaust blowers and fresh air supplied by pressure blowers.

The dough mixer and dishwashing motors are directly connected to the machines they operate and are of 2.5 and 1 h. p. each, respectively. The laundry motor is a General Electric 7.5 h. p. shunt wound motor. It is used for driving the washing machines, mangles, etc. In the machine shop, there are two Union Iron Works 5 h. p. shunt wound motors. They are used for driving the various machine tools, such as planer, shaper, lathes, etc. There are two fresh water pumps, driven by two Union Iron Works 3 h. p. shunt wound motors which are geared direct to plunger pumps.

There are two four-stage torpedo air compressors capable of furnishing 30 cu. ft. of air per hour at 2500 lbs. pressure per sq. in. The motors are semi-enclosed, shunt wound and are directly connected to the compressors. They are six pole and have six sets of brushes and their capacity is 50 h. p. each when running 500 revolutions and using 350 amperes at 125 volts.

There are four boat cranes; one of 33,000 lbs. capacity, one of 17,000 lbs. and two of 5,600 lbs. capacity each. Each crane is equipped with two motors, one for hoisting and lowering and one for rotating. They are connected to the gearing of the hoists through slip-clutches and each motor is fitted with an electric brake. They are controlled by drum controllers using the Day system of control. The boat cranes are used for handling all the small boats and launches, and also for coaling ship.



Motor Driven Ventilating Set.

The Day system of control is well adapted to boat cranes, and when lifting and lowering, the loads are strictly under the control of the operator.

The boat cranes are equipped with Union Iron Works shunt motors. The 33,000-lb. crane having a 50 h. p. and 30 h. p. motor for lifting and rotating and requires at full load 360 and 208 amperes respectively at 125 volts; the 17,000-lb. crane is equipped with a 30 h. p. and 20 h. p. motor and the full load currents are 208 and 146 amperes; and the two 5,600-lb. cranes are equipped with 20 and 15 h. p. motors for lifting and rotating respectively and the full load currents are 146 and 108 amperes at 125 volts.

During the acceptance tests, all motors were obliged to handle a load of double the weight of the heaviest launch, and also tests were made to ascertain whether the control would be affected by any movement of the ship; such as rolling and pitching to the extent of 10 degrees. The maximum loads were raised and lowered slowly and rapidly and exactly, at the will of the operator.

There are seven deck winches, each fitted with General Electric Co. 30 h. p. series wound enclosed motors, and controlled with drum controllers. They are capable of being reversed, and by means of change gearing, double the load can be handled at half speed or normal load at normal speed. The winches are used for shipping cargoes, coaling ship, etc.

The Main Switchboard.

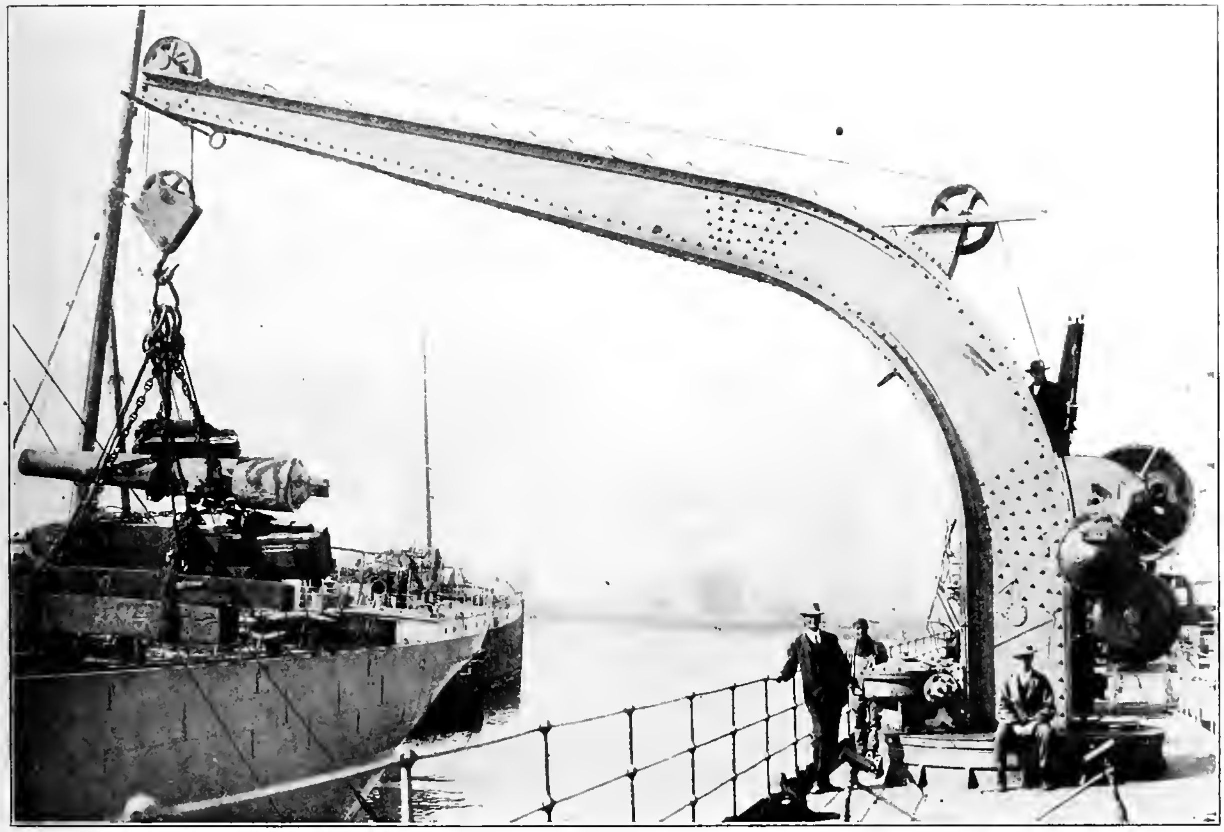
The main switchboard, consisting of enameled slate panels for four 50 k. w. and three 100 k. w. generators, one light distributing panel and one power distributing panel, is located in the upper dynamo room. This switchboard, a diagrammatic sketch of which is shown in the accompanying illustration, is generally arranged in such manner as will allow any number of combinations of dynamos to be run on any circuit or combination of circuits. These circuits are five in number, viz.: Searchlight, lighting, power, forward turret turning and after turret turning.

To accomplish this the negative pole of each machine can be connected by a single-pole, single-throw switch to a horizontal common negative bus bar, whereas there are seven vertical positive generator bus bars, one for each machine. Back of these bars are five horizontal positive circuit bus bars, and where these two sets cross, there are single-pole, single-throw switches which allow the positive leg of each, any, or all the dynamos to be connected to each, any or all circuits, with the exception of the three 100 k. w. generators, which do not connect with the turret turning bus bars. Therefore, there are $5 \times 4 + 3 \times 3 = 29$ points of contact on the positive bus bars.

For paralleling the dynamos there are two separate equalizer bus bars, one for lighting and another for power (there being no occasion for paralleling machines on searchlight circuits). Such dynamos as may be desired are connected to these equalizer bus bars by removable blade plug swicthes. The two turret turning bus bars are not considered here, but will be described later.

The two dynamo panels are arranged in vertical sections, one section for each machine. Each section contains all the apparatus necessary for the operation of its own dynamo. Starting at the top of the panel we have first the circuit breaker, then the ammeter, then the ammeter shunt (on the back of the board), then the hand wheel for operating the field regulator or rheostat, which is operated by a spindle passing through the slate panel. Next comes the plug receptacle for connecting to the voltmeters, and then three single-pole, single-throw positive dynamo switches by means of which the dynamo may be connected (proceeding in order, starting with the upper switch) First, to searchlight bus; second, to lighting bus; third, to power bus for 100 k. w. generators only; fourth, to forward turret turning bus; fifth, to after turret turning bus for the 50 k. w. generators in the same vertical row. But on the lower panel there are three single-pole, single-throw switches. The upper one connects the negative leg of the dynamo to the negative bus bar, the middle one connects the lighting equalizer and the lower one the power equalizer.

On the right hand (or 50 k. w. generator) panel, there are eight three-pole, single-throw field-control

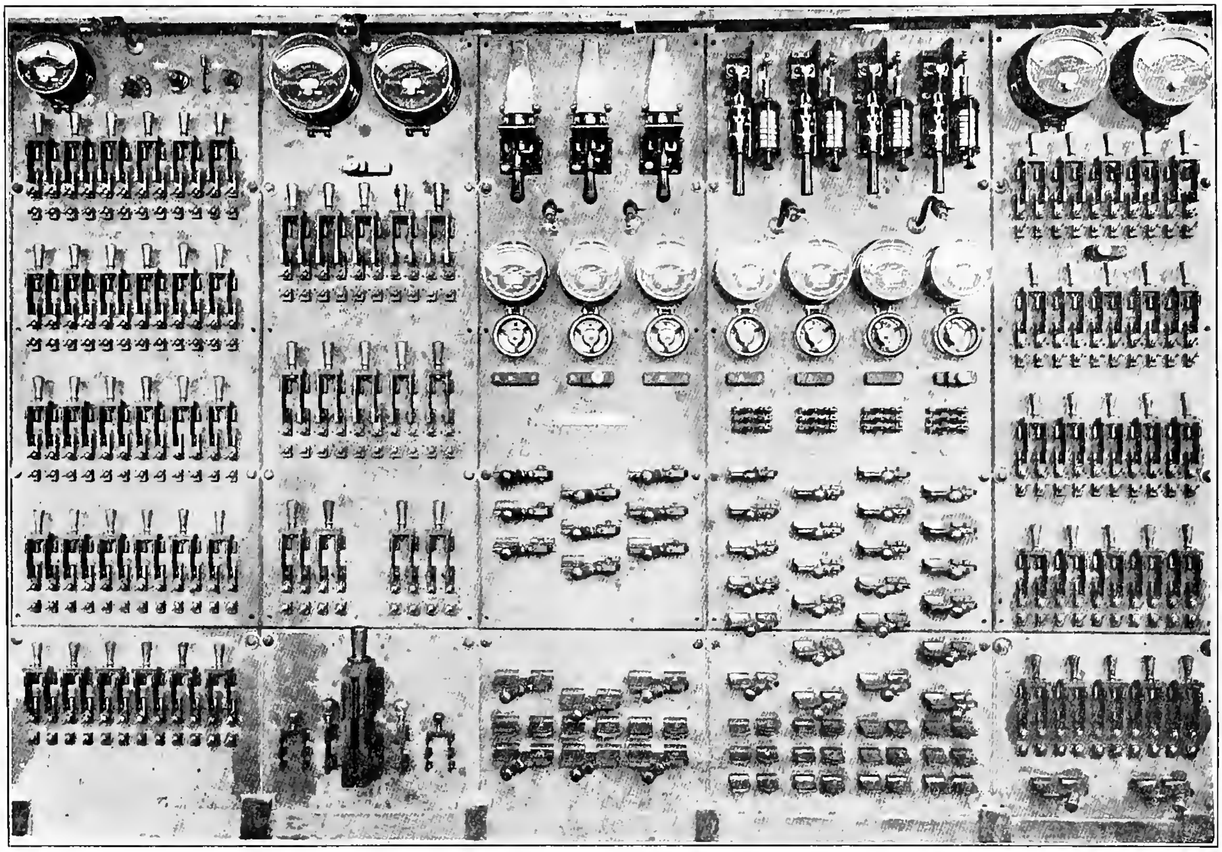


33,000 lb. Boat Crane Handling Steel Weighing 66,145 lbs.

switches, the hinged ends of which connect to the terminals of the shunt fields of the 50 k. w. generators. The field-control switches allow three methods of field excitation: By closing the two upper switches the machine is made self-exciting; by closing the two middle switches the machine is separately excited and controlled from the forward turret by the Ward-Leonard system described elsewhere; by closing the two lower switches the machine is separately excited and controlled from the after turret.

the shunt resistance coils located on the back of the lower panel.

To the left of the generator panels is the power distribution panel carrying 44 single-throw, double-pole switches. Arranged at the top of the panel is a voltmeter ground-detector with a six point switch connecting with the five positive bus bars and the common negative. There is also an ordinary lamp ground-detector, with lamp receptacle which is provided with a switch for breaking the ground connection (this operation being necessary before using the voltmeter ground-detector). This panel also contains two voltmeters with plug receptacles underneath.



Main Switchboard.

Power Panels. Generator Panels. Lighting Panel.

When the dynamos are used to operate the turret turning motors, the series fields are short-circuited through the shunts which are located on the back of the lower panel and are controlled by single-pole-single-throw switches at the base of the board, one switch to each machine. Referring to the figure, it will be noted that the switches of generator No. 4 are set for operating the after turret and that of generator No. 7 are set for self-excitation only.

On the lower left-hand, or power, panel there are three vertically-set, single-pole, single-throw, and two double-pole, single-throw switches with shunt attachments. The middle one connects the negative power distributing bus to the common negative bus, and the outer ones perform the same function for the negative turret leads; the switch for the forward turret being on the left-hand side. The two double-pole switches connect to the fields of the turret turning motors and are so arranged that the operation of opening the switch directs the discharge of the field coils through

At the bottom of the right-hand, or lighting, panel there are two single-pole, single-throw switches. The left-hand one of these connects the negative lead to the searchlight panel (hereinafter described) to the common negative bus. The right-hand switch performs a similar function with respect to the negative light distributing bus bar.

All switches horizontally placed on generator panels are hinged on dynamo end and throw to the left. For the equalizers, removable blade, plug switches are used. Four blades are provided for each equalizer, and two for each of the other circuits. i. e., forward turret, after turret and series shunt. When a switch is open the clip is plugged with a stop, to prevent accidental closing. Should it be desired to operate all seven generators in parallel, they may all be equalized on either the light or power equalizer bar.

The voltmeter connections are shown in the diagram, the plug receptacle on the power panel and the three receptacles of the left dynamo panel, i. e., for machines Nos. 1, 2 and 3, have a spacing of 1 inch and 2 inches, whereas the receptacles on the lighting panel and those for machines Nos. 4, 5, 6 and 7 have a spacing of 1½ and 2½ inches. By using the 1-inch plug in any receptacle on the dynamo panel the voltage is read on voltmeter No. 1. Likewise, by using the 2-inch plug, the voltage can be read on voltmeter No. 2. Similarly, on the right hand dynamo panel the 1½-inch plug throws voltmeter No. 3 across the dynamo terminals and the 2½-inch plug throws voltmeter No. 4 across the terminals. Thus we can read the voltage of any two machines on the left hand panel and of any two machines on the right hand panel (four machines in all), simultaneously.

the receptacle is made complete when the common negative generator switch is closed; fourth, plug to voltmeter and adjust voltage by field regulator; fifth, and last close positive swtich.

For detecting grounds, the lamp detector on the upper part of the power panel is connected permanently across the common negative bus and the positive leg on the lighting circuit bus, and when using the voltmeter ground detector the ground connection on this lamp ground detector must be broken by opening the ground switch. The connections to the voltmeter ground detector are such that when a circuit is grounded on the positive leg, the instrument will indicate when plugged to negative, and for a ground on the negative of any circuit, the instrument will indicate when plugged to any of the positive circuit bus bars; provided that said bar is alive, and here it should

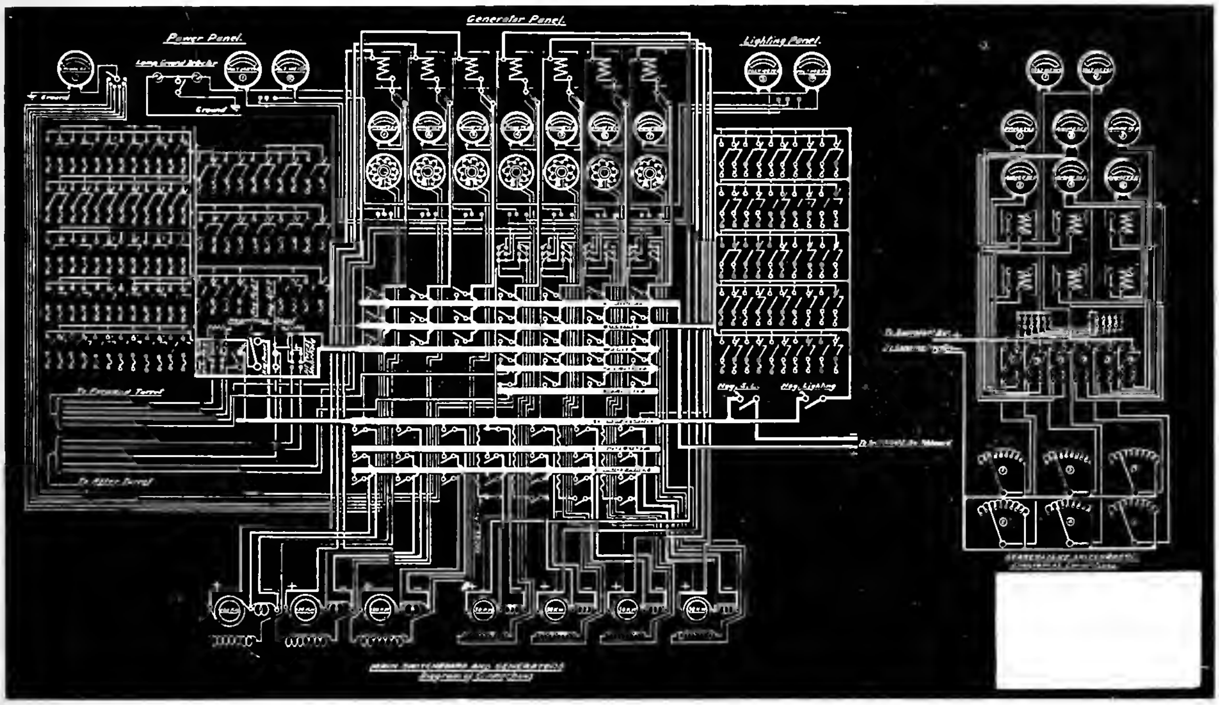


Diagram of Connections of Main and Searchlight Switchboards.

With the 2-inch in a receptacle on the dynamo panel and the 1-inch plug in the receptacle on the power panel, we have voltmeter No. 1 in parallel with voltmeter No. 2, for calibration. With the 1-inch plug in a receptacle on the dynamo panel, the 2-inch in the receptacle on the power panel, and the 1½-inch plug in the receptacle on lighting panel, voltmeters Nos. 1 and 3 are in parallel. By substituting the 2½-inch plug for the 1½-inch plug in the above arrangement Nos. 1 and 4 are in parallel. As only one plug of each spacing is furnished, it is impossible to make a short circuit or parallel two machines on the voltmeter connections. An inspection of the diagram will show this to be true.

When starting up a new machine to be parallel with one already running, the operation at the switchboard is as follows: First, close the equalizer switch; second, close the circuit breaker; third, close the switch to common negative the voltmeter connection up to

be noted that a bar is alive when any switch in the horizontal row connecting to it is thrown.

Searchlight Switchboard.

The searchlight panel is located near the main switchboard; it consists of a single enameled slate panel set in an iron frame, and has mounted upon it the various instruments and accessories for the searchlights in the following order; at the top of the panel are the common voltmeters for all six search-lights; next come the six ammeters, three abreast and then six double pole G. E. Company circuit breakers similarly placed. Below these are the plug receptacles for the voltmeters, then six double pole, single throw switches, fused, and finally at the bottom of the board, are the adjusting levers and contacts for the regulators. The latter are mounted back of the searchlight panel and are connected with their contacts by means of cables.

Referring to the figure showing the diagram of connections, the negative lead from the switch on main board connects to a common negative bar behind the searchlight panel. This supplies one side of all regulators; the other side being connected to the respective circuit switch. The positive side of each circuit switch is fed by the lead from the positive searchlight bus bar on main board. From the circuit switch the negative lead to each lamp connects through the right hand side of the circuit breaker and thence to the lamp. The positive lead passes through the ammeter to left hand side of circuit breaker, thence to the lamp.

The voltmeter connections are made in the following manner; the voltmeter positive is connected directly to the positive bus bar, and the negative to the six upper contacts of the voltmeter receptacle. The six lower contacts of the latter are connected in order to the negatives of the six switches (on the regulator side).

Two voltmeter plugs are supplied and these, when inserted vertically in any one of the set of six pairs of contacts, completes the circuit through the voltmeter, which shows the voltage across the feeders; the voltage across arc of lamp (plus drop of voltage on feeders), being indicated.

There are two voltmeters and two receptacles of six pair of contacts, each mounted on the panel, thereby enabling readings to be taken in parallel for calibration, or the voltage may be read from any two lamps.

The ground detector, volt and ammeters are of Weston Round pattern type; the circuit breakers and searchlight rheostats are G. E. Co.; the field rheostats are The Ward-Leonard round enameled type; all of the switches are of the Navy Standard type and made by the Union Iron Works.

System of Current Distribution.

The lighting and power systems are subdivided as heretofore mentioned under caption of "Lighting System" and "Power System," in accordance with the usual practice, into the requisite number of circuits. On the lighting panel there are 25 switches; these with the exception of one that controls the feeder for wireless telegraphy, are employed in connection with the lighting feeders which, in turn supply their respective mains and branches.

The power circuit panel is supplied with 44 section switches. These control all power circuits except the two for turret turning, which are fed from the turret bus bars, as heretofore described.

The size of feeders, mains, etc., and means of installing are in accordance with the Bureau of Equipment, Navy Department specifications for installing electric plants and electrical means of interior communicatioins on board ships of the United States Navy The maximum load for feeders for lighting circuits does not exceed 75 amperes per feeder. This is based on a basis of 0.5 of an ampere for 16 c. p. incandescent lamps or 1/12 h. p. fans, and 1 ampere for 32 c. p. incandescent lamps of 1/6 h. p. fans.

Several mains of the same class of service may be grouped on the same feeder, provided the total load is not in excess of 75 amperes. The cross sectional area of the feeders and mains are such that the fall in potential from the dynamo terminals to the most distant outlet does not exceed 3 per cent at the normal load of the feeder. Also the feeders and mains must have a cross-section of not less than 1,000 circular mils per ampere at the normal load.

Power feeders and mains for continuous service; such as ventilation, laundry and machine shop motors, must have a cross-sectional area of 1,000 circular mils per ampere, and not less than 500 circular mils per ampere for intermittent service; such as ammunition hoist, boat crane and winch motors.

Motors whose normal full load working currents are less than 50 amperes are grouped on the same feeder, but no such feeder has a load in excess of 100 amperes. Each motor whose normal full load working current exceeds 50 amperes has a separate feeder, and the cross-sectional area is such that the fall in potential from the dynamo terminals to the motor terminals does not exceed 5 per cent at normal full load. For motor feeders carrying more than one motor, the fall in potential from the dynamo terminals to motor terminals does not exceed 3 per cent at total full load. Where mains are lead off from feeders it is done through Navy standard junction boxes, having double pole fuses, which on lighting circuits blow on the basis of 1 ampere per 500 c. m. of the main; and on the power circuits blow at double the normal current of the motor.

The two feeders supplying the lighting mains of the main engine rooms are arranged with interconnecting switches. Should either feeder for any reason fail, the two engine rooms may be carried on one feeder; in which case, the area of such interconnecting feeders is 1,500 c. m. per ampere.

Method of Installing

The ship is wired on the two-wire system. The method of installing the electric light and power and interior communication circuits consists of a combination of steel and brass enameled conduit; the conduit is used throughout the ship and is insulated as follows:

The enameled conduit is made up of standard gas pipe sizes. The enamel consists of three coats baked on, inside and out, and is not affected by moisture, alkalies, etc. Brass conduit, which is insulated in a similar manner as the steel conduit, is used in magazines and an the superstructure where wiring in conduit is run within twelve feet of the standard compass.

Conduit is made water-tight through bulkheads and decks by means of bulkhead stuffing tubes and deck stuffing tubes. Gland couplings or water-tight boxes are also used on conduit where it passes from the non-water-tight to a water-tight compartment; and on every lead of conduit between two junction boxes in order to prevent water from passing from box to box should one become flooded. Where conduits terminate at a bulkhead or otherwise, terminal tubes are used. The deck tubes and bulkhead stuffiing tubes are used on the interior communication installation as well as for the light and power.

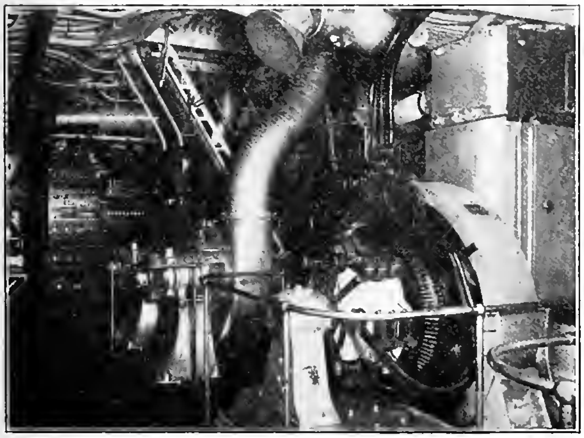
Conduit is made continuous where run through decks, by means of a combination of Navy standard washers and nuts, together with a gland coupling, it is run through water-tight bulkheads by means of Navy standard bulkhead stuffing boxes, which allow for play of the bulkhead on the conduit. A water-tight box is used on conduit where it passes through

a non-water-tight compartment to a water-tight compartment, in order to prevent flooding, should a break in the lead occur.

Conduit is secured to the beams or bulkheads with suitable iron straps. Conduit wiring accessories used are of the Navy standard type, adopted by the Bureau of Equipment. Great care is taken to see that covers on all distribution boxes, feeder boxes, junction boxes, switches and switch and receptacles are securely fastened. Fixtures and accessories in the engine and fire rooms are most liable to injury from loose covers when washing down, and only electricians or those in authority are allowed to open boxes for inspection or for renewing fuses.

Method of Marking Circuits.

A glance at the network of conduits shown above the engine and switchboard will substantiate the necessity of an elaborate system of marking circuits. All conduits and voice pipes are marked with a capital letter designating the character of the lead as follows: Lighting Feeders, Battle Service, B; Searchlight Feeders, B; Lighting Feeders, Lighting Service, L; Power Feeders, P; Interior Communication Leads, I; Voice Pipes, V.



Upper Dynamo Room, showing 50 k. w. Generating Set and Switchboard.

All battle, searchlight and power feeders are numbered serially as B-1, L-14, P-46, etc., the numbers corresponding to the approved wiring plans.

All voice pipes are numbered serially in accordance with the approved list, as V-1, V-2, etc.

All mains and branches on the battle, lighting or power feeders are numbered serially and are given a small case letter b, l or p, respectively, proceeded by the serial number of the main and followed by the serial number of the feeder, i. e. mains on B-14 are numbered 1-b-14, 2-b-14, 3-b-14, etc.; main 1-b-14 is the one branching off the feeder at that point in its run which is nearest to the switchboard or the distribution board from which the feeder is supplied.

All interior communication circuits, in addition to the capital letter I have the designating letter of the circuit as marked in the list and on the wiring plans, using a small case letter thus: Admiral Calls, I-a; Warning Signals, I-q; Electric Log, I-y; etc., etc.

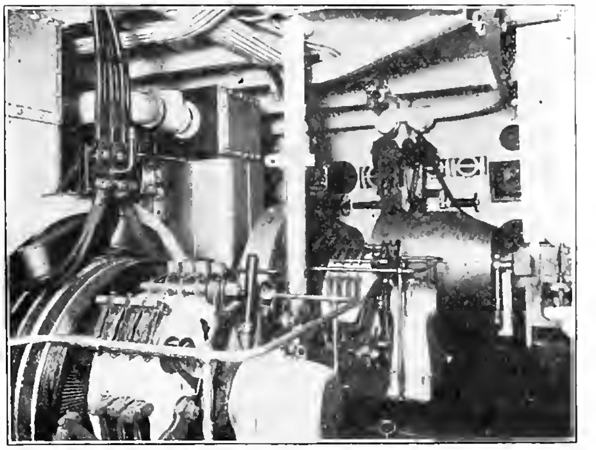
Where an interior communication lead contains wires for more than one circuit, the designating letters of all the circuits contained are listed, the order of the letters indicate the order of predominance of the several circuits: Thus a circuit carrying in the main voice tube calls, also some telephone talking wires, and one or two captain's calls, is marked I-e-j-a.

Each lead in all the compartments is tagged; a metal tag stamped as per above description is firmly secured to the conduit or voice pipe in a manner which permits the marking of the tag to be readily discerned; the tags may be seen on conduits above the switchboard in the illustration.

Generating Sets.

The electric generating plant consists of seven Union Iron Works generating sets, three being of 100 k. w. capacity; 800 amperes at 125 volts and 275 r. p. m., and four of 50 k w. capacity; 400 amperes at 125 volts and 350 r. p. m.

The three 100 k. w. and one of the 50 k. w. sets



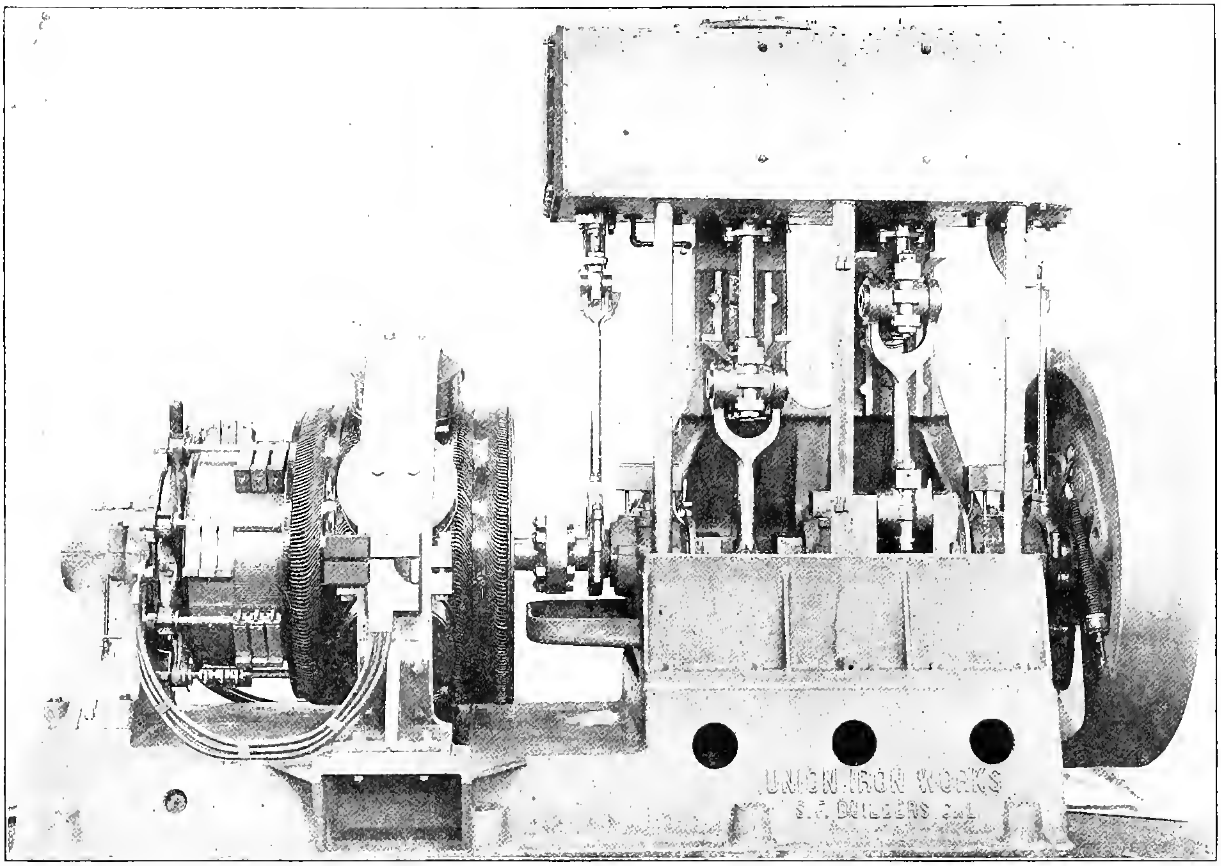
100 k. w. Sets in Lower Dynamo Room.

are located in the lower dynamo room; the other three 50 k. w. sets are located in the upper dynamo room along with the switchboard.

In each set, the engine and generator is mounted on a bed plate of oblong shape which is provided with recesses and is mounted on a foundation of teak wood. The bed plate is secured in place with bolts which pass through the foundation and deck. The nuts for the belts setting up against the bed plate in easily accessible locations. The bed plate and foundation are surrounded by a framing of angle iron secured to the deck and thus forming a waterway to receive waste oil and water.

The engines are of the double-acting, vertical, inverted cylinder, cross-compound type, designed to operate either condensing or non-condensing. They were designed to operate under the former condition with 100 lb. steam pressure, but, owing to changes in the specifications for generating sets, whereby the standard pressure has been increased from 100 to 150 lb., 125 lb. was selected as the normal working pressure for these engines.

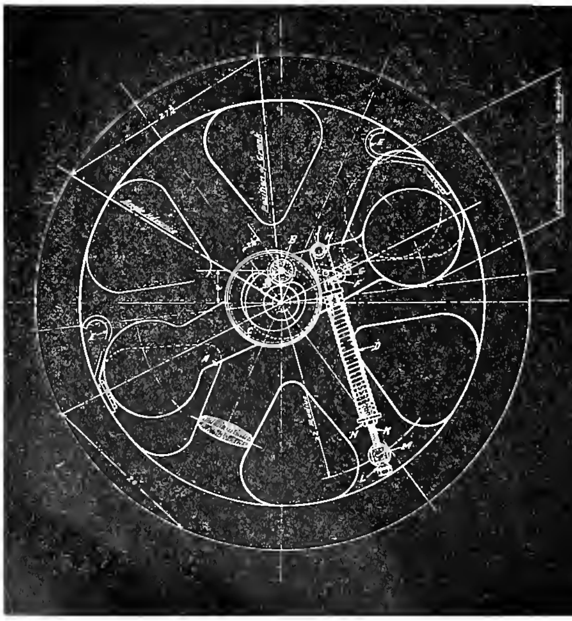
The operation at this pressure is satisfactory and the engines have been thoroughly tested to demonstrate their adaptability to pressures 20 per cent above and 20 per cent below the normal. The log of tests, which are given herein, shows the typical performance



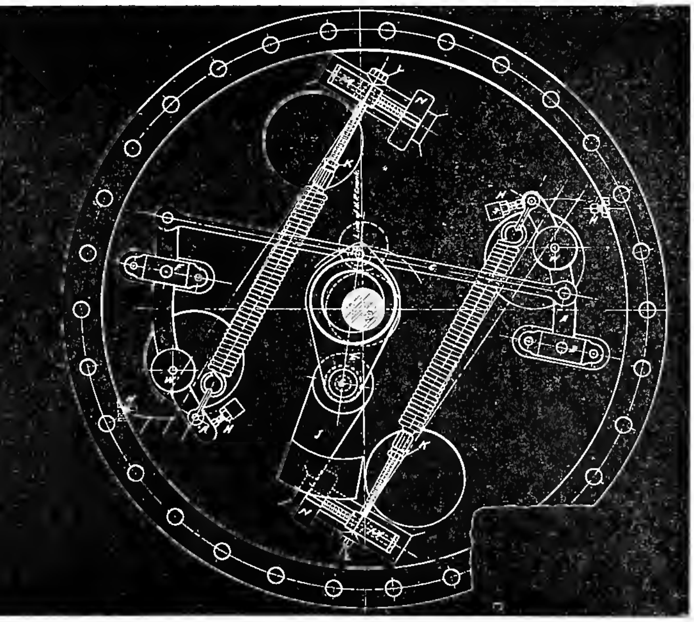
100 k. w. Generating Set Showing Engine with Oil Guards Removed.

of each engine under all conditions imposed by the standard specifications of the Bureau of Equipment. The engines are of the open frame type, but are provided with all necessary oil guards.

The governor of the 50 k. w. engine is of the inertia type and is mounted in the fly wheel. The ideal conditions are attained when the load on the engine is steady and the pull of the springs is exactly balanced by the centrifugal force acting on the weights. Under these conditions any variation of load is taken care of by the governor without much change in the speed of the engine, as a difference of a few revolutions, fast or slow, will suffice to produce sufficient change in the valve-travel to compensate for a change



Rite's Inertia Governor.



Union Iron Works Inertia Governor.

of from full load to no load, and at the same time maintain a steady speed. The general arrangement of the governor is shown in accompanying figure.

The description of the 50 k. w. engine applies to the 100 k. w. engine, they being of the same general design and type, with the exception of the governor. The governor of this engine is of a very simple construction. It is known as the "Rite's" dumbbell governor, and is manufactured by the Union Iron Works under an agreement with the patentee. This governor can be adjusted so that it will make the engine run at the same speed with the full load or no load, or even several revolutions faster at full load than with the load off. As space will not permit, will not endeavor to discuss the characteristics of the governor further than to state that any further adjustments to increase the full load speed more than that shown in the regulation tests shown herein, has a tendency to cause unsteady speed or searching of the governor, owing to having reached the critical point of the governor springs.

The 50 k. w. generators are of the multipolar type, having six poles mounted in a circular field ring or yoke. They are compound wound and were designed for a constant potential of 125 volts at the terminals when running at 350 r. p. m. The full load current is 400 amperes. The armature which is of the simple type known as the "Gramme ring," and is slotted; the total number of slots being 108. The teeth are "T" shaped, the overhang of these teeth serving to retain in place the hardwood slot-wedges, which hold the armature conductors in place in the slots without the aid of binding wires. The armature connection employed is that commonly known as the "simplex ring" having parallel, singly-reentrant grouping of conductors. The conductors are connected in series all around the armature. As the machine has six poles and the same number of brush studs and sets of brushes, the winding is one of six paths.

This type of armature is without doubt one of the best for installations where repairs are made on board ship. The writer has seen several defective coils replaced in as many hours, without disturbing or removing the upper half of the field frame; the removal of engine oil guards only being necessary.

In the construction of the field coils, the shunt winding is wound directly over the series of compound winding; there are no series shunts; the total armature current passing through the series coils.

The 100 k. w. generators are also of the multi-pole type, have eight poles, are compound and were designed for a constant potential of 125 volts at the terminals when running 275 r. p. m.; the full load current is 800 amperes. The general design is the same as that of the 50 k. w. with the exception of the armatures and series field coils. The armature coils number 240, they are form wound and the winding is the "simplex lap winding," in which the end of each coil situated in fields of opposite polarity, is connected through a commutator segment to the beginning of a coil lying within the arc embraced by the former. With reference to the direction of connecting, the beginning of every following coil lies back of the end of the foregoing, thus the winding forms a series of loops which overlap each other.

The armature coils are held in place by means of hard bronze wire bands; four are spaced across the core proper, and two each embrace the front and back heads respectively; there is also a wide cotton cord band over the leads where they join the commutator. The field coils differ from the 50 k. w. only in respect to the series coils, to the terminals of which german silver shunts are attached; they are located on the back of the terminal boards.

Tests.

In concluding this article the writer wishes to call attention to the method in which the tests of the generator sets were conducted. As space will not permit, only the log sheets and plotted curves of one of the generating sets has been given. As the generators and engines are practically of the same type, the tests of the generating set No. 1, which is of 100 k. w. capacity may be considered as typical of the performance of each of the other generating sets.

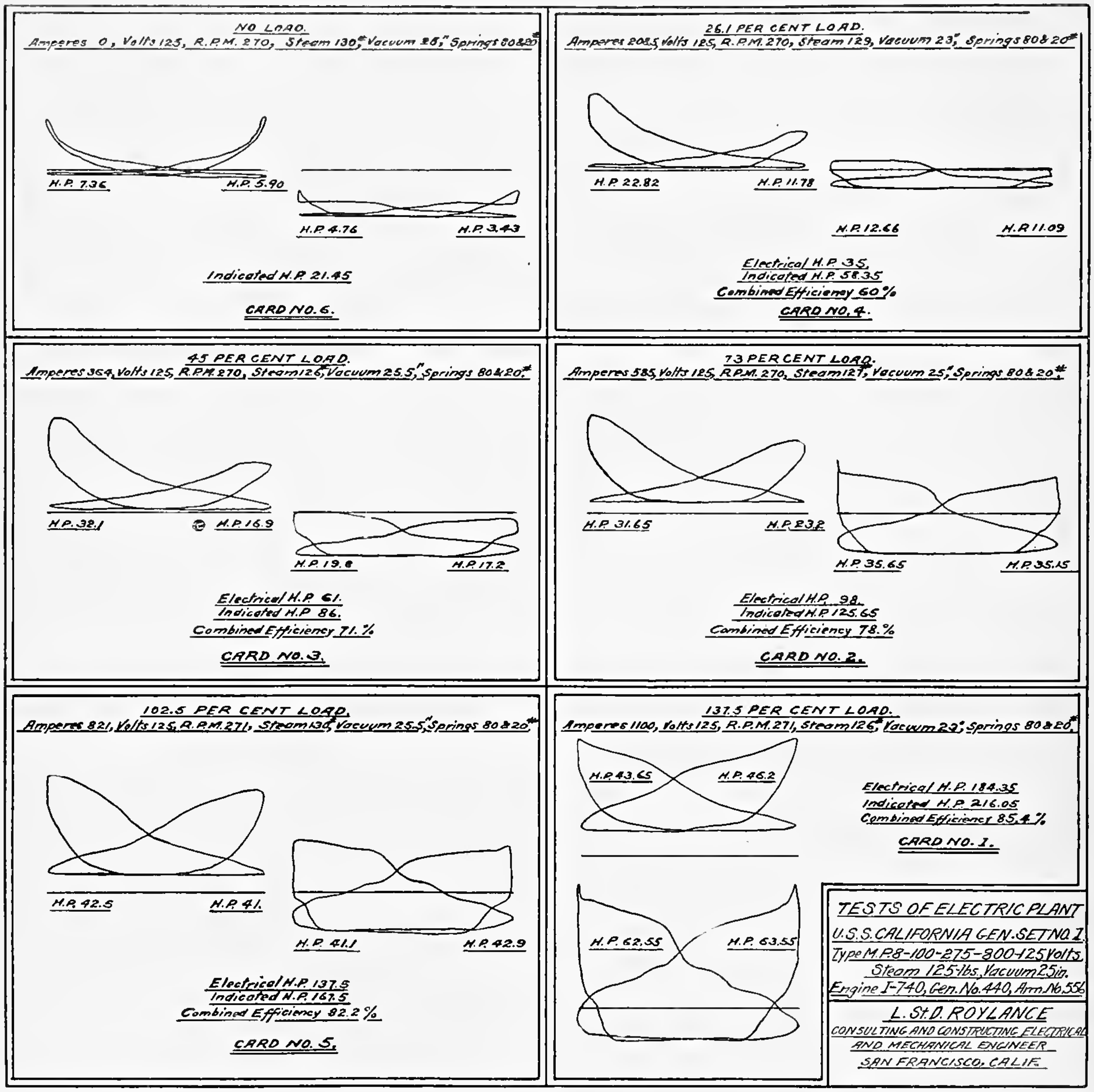
The log sheet shows the performance of the set from the start of the test with 1/3 overload, continuing with various loads and ending with full load for the last six hours of the test. In reference to the compounding test, the potential variation allowed is 2 per cent or 2½ volts above or below 125 volts, and the jump in voltage must not exceed 15 per cent when the full load is suddenly thrown on and off. The requirements for engine regulation are that the speed variation must not exceed 2½ per cent when the load is varied between full load to 20 per cent of full load, gradually or in one step, engine running with normal steam pressure and vacuum. A variation of not more than 3½ per cent will be allowed when the full load is suddenly thrown on or off the generator, with constant steam pressure and vacuum, either normal or 20 per cent above normal; a variation of not more than 3½ per cent will be allowed when 90 per cent of full load is suddenly thrown on or off the generator with constant steam pressure at 20 per cent below normal: exhaust in both cases to be into condenser or atmosphere. No adjustment of the governor or throttle valve is allowed during the test to insure proper performance under any of the above conditions.

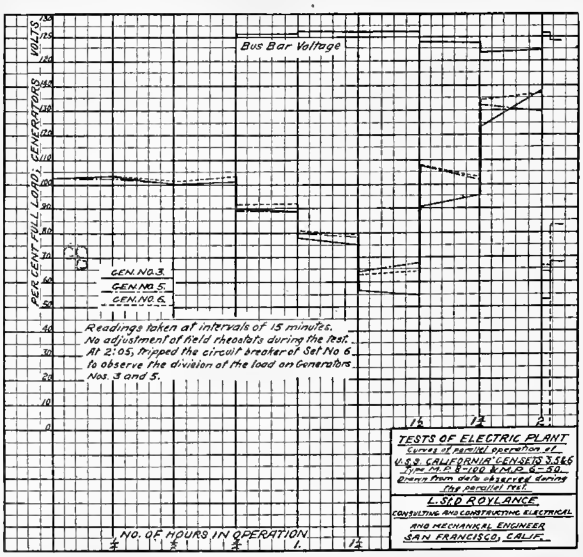
The water consumption allowed for the generating sets at full load, is not to exceed 35 and 31 lbs. per k. w. hour, respectively for 50 k. w. and 100 k. w. at normal steam pressure of 150 lbs. The tests of these generating sets were at a normal pressure of 125 lbs., therefore at 150 lbs. the results would be slightly lower than that obtained. The water consumption for the 50 k. w. sets at various loads is as follows: ¼ load, 57.751 lb.; ½ load, 41 lb.; ¾ load, 36.20 lb.; full load, 33.5 lb.; 1/3 overload 32 lb. per k. w. hour.

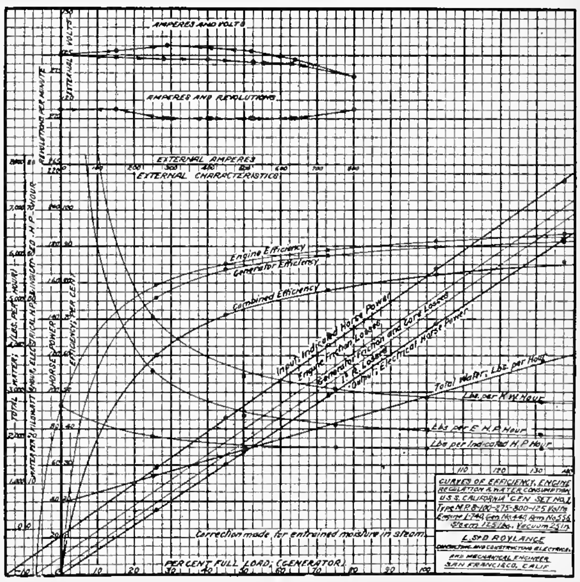
The minimum allowed efficiencies for 50 k. w. and 100 k. w. generators are: ½ load, .86 and .87; ¾ load, .88 and .89; full load, .89 and .90; and 1/3 overload, .89 and .90, respectively.

The temperature rise of the sets after running continuously under full rated load for four hours must not exceed the following:

Armature by thermometer 33 1/3 deg.; commutator by thermometer, 40 deg.; field coils, by rise of resistance 33½ deg.; shunt rheostat, by thermometer, 75 deg.; and series shunt, by thermometer, 40 deg. The


NO LOAD.
Amperes 0, Volts 125, R.P.M. 270, Steam 130#, Vacuum 26", Springs 80&20#
H.P. 7.36
H.P. 5.90
H.P. 4.76
H.P. 3.43
Indicated H.P. 21.45
CARD NO. 6.
26.1 PER CENT LOAD.
Amperes 208.5, Volts 125, R.P.M. 270, Steam 129, Vacuum 23", Springs 80&20#
H.P. 22.82
H.P. 11.78
H.P. 12.66
H.P. 11.09
Electrical H.P. 35.
Indicated H.P. 58.35
Combined Efficiency 60 %
CARD NO. 4.
45 PER CENT LOAD.
Amperes 364, Volts 125, R.P.M. 270, Steam 126, Vacuum 25.5", Springs 80&20#
H.P. 32.1
H.P. 16.9
H.P. 19.8
H.P. 17.2
Electrical H.P. 61.
Indicated H.P. 86.
Combined Efficiency 71. %
CARD NO. 3.
73 PER CENT LOAD.
Amperes 585, Volts 125, R.P.M. 270, Steam 127, Vacuum 25", Springs 80&20#
H.P. 31.65
H.P. 23.2
H.P. 35.65
H.P. 35.15
Electrical H.P. 98.
Indicated H.P. 125.65
Combined Efficiency 78. %
CARD NO. 2.
102.5 PER CENT LOAD.
Amperes 821, Volts 125, R.P.M. 271, Steam 130, Vacuum 25.5", Springs 80&20#
H.P. 42.5
H.P. 41.
H.P. 41.1
H.P. 42.9
Electrical H.P. 137.5
Indicated H.P. 167.5
Combined Efficiency 82.2 %
CARD NO. 5.
137.5 PER CENT LOAD.
Amperes 1100, Volts 125, R.P.M. 271, Steam 126, Vacuum 23", Springs 80&20#
H.P. 43.65
H.P. 46.2
Electrical H.P. 184.35
Indicated H.P. 216.05
Combined Efficiency 85.4 %
CARD NO. 1.
H.P. 62.55
H.P. 63.55
TESTS OF ELECTRIC PLANT
U.S.S. CALIFORNIA GEN. SET NO. 1
Type M.P. 8-100-275-800-125 Volts,
Steam 125 lbs. Vacuum 25 in.
Engine I-740, Gen. No. 440, Arm. No. 556
L. St.D. ROYLANCE
CONSULTING AND CONSTRUCTING ELECTRICAL AND MECHANICAL ENGINEER
SAN FRANCISCO, CALIF.


PER CENT FULL LOAD, GENERATORS — VOLTS
Bus Bar Voltage
GEN. NO. 3.
GEN. NO. 5.
GEN. NO. 6.
Readings taken at intervals of 15 minutes.
No adjustment of field rheostats during the test.
At 2:05, tripped the circuit breaker of Set No. 6
to observe the division of the load on Generators
Nos. 3 and 5.
NO. OF HOURS IN OPERATION
TESTS OF ELECTRIC PLANT
Curves of parallel operation of
U.S.S. CALIFORNIA GEN. SETS 3, 5 & 6
Type M.P. 8-100 & M.P. 6-50
Drawn from data observed during the parallel test.
L. St.D. ROYLANCE
CONSULTING AND CONSTRUCTING ELECTRICAL AND MECHANICAL ENGINEER
SAN FRANCISCO, CALIF.


AMPERES AND VOLTS
AMPERES AND REVOLUTIONS
EXTERNAL AMPERES
EXTERNAL CHARACTERISTICS
Engine Efficiency
Generator Efficiency
Combined Efficiency
Input, Indicated Horse Power
Engine Friction Losses
Generator Friction and Core Losses
I^2R Losses
Output, Electrical Horse Power
Total Water, Lbs. per Hour
Lbs. per Kw. Hour
Lbs. per E.H.P. Hour
Lbs. per Indicated H.P. Hour
Correction made for entrained moisture in steam.
PER CENT FULL LOAD, GENERATOR
CURVES OF EFFICIENCY, ENGINE REGULATION & WATER CONSUMPTION
U.S.S. CALIFORNIA GEN. SET NO. 1
L. St.D. ROYLANCE
SAN FRANCISCO, CALIF.

U. S. S. CALIFORNIA — LOG OF 48-HOUR SERVICE TEST

No. of Set on Ship, 1 — Engine No. 1-740 — Location Lower Dynamo Room — 100 K.W. Frame 440 — Armature No. [illegible]

DATA OBSERVED BEFORE STARTING SET ON 48-HOUR RUN (GENERATOR COLD).	
Resistance of Shunt Field, (Ohms)	8.84
" " Field Rheostat	7.37
Range of Field Rheostat, (Minimum volts)	60.00
" " " (Maximum ")	147.00
" " " (Minimum amperes)	3.66
" " " (Maximum ")	12.46
Temp. " Coils, (Thermometer C°)	24.00
" " Armature, " "	24.00
" " Commutator, " "	24.00
" " Field Rheostat, " "	25.00
" " Generator Switches, " "	27.00
" Air at Machine, " "	24.00
Check Switchboard Instruments	Instruments Checked; Errors Corrected

INSULATION RESISTANCE, (COLD).	
Voltmeter Resistance, (Ohms)	500,000.00
Line E.M.F.	200.00
Armature to Shaft, (Megohms)	1.17
Frame to Bedplate, (Megohms)	1.17
Shunt Field to Frame, "	1.16
Series " " " "	1.16
Shunt Field to Series, "	1.10
Positive Brush Studs to Ground "	1.10
Negative " " " " "	1.10

Time	Volts	Amperes	R.P.M.	Steam	Vacuum	Temp Field Coils	Temp Air	Card No.
2 HOURS WITH ONE-THIRD OVERLOAD.								
11:30	120	1010	271	130	24.0	24.0	24.0	
12:00	125	1040	271	130	23.0	40.0	26.0	
12:30	126	1065	271	126	23.0	47.5	26.0	
1:00	126	1092	271	126	23.0	50.0	29.0	
1:30	126	1100	271	126	23.0	62.0	28.0	1
13 HOURS WITH THREE-QUARTER LOAD.								
1:30	126	600	270	126	23.0	62.0	28.0	
2:00	125	610	270	126	23.0	61.0	28.0	
2:30	126	605	270	127	24.0	61.0	28.0	
3:00	126	660	270	127	24.0	62.0	29.0	
3:30	126	615	270	127	24.0	61.0	27.5	
4:00	126	620	270	126	25.0	60.5	27.0	
4:30	126	685	270	127	25.0	60.0	27.0	2
5:00	125	607	270	127	25.0	60.0	26.5	
5:30	125.5	620	270	130	25.0	60.5	26.5	
6:00	125	615	270	127	25.0	60.0	26.0	
6:30	125	640	270	127	25.0	50.0	26.0	
7:00	124.5	615	270	127	25.0	50.0	26.0	
7:30	125	640	270	128	25.0	49.0	26.0	
8:00	126	620	270	128	25.0	49.0	25.0	
8:30	126	620	270	128	25.0	48.0	26.0	
9:00	125	620	270	128	25.0	48.0	26.0	
9:30	125	650	270	127	25.0	47.0	25.0	
10:00	124.5	600	270	128	25.0	46.5	25.0	
10:30	124	620	270	127	25.0	46.5	25.0	
11:00	124	600	270	128	25.0	46.5	25.0	
11:30	124.5	610	270	128	25.0	46.5	25.0	
12:00	125	610	270	128	25.0	46.5	25.0	
12:30	126	610	270	129	25.0	45.5	25.0	
1:00	126	610	270	130	24.0	45.5	24.5	
1:30	126	605	270	130	25.0	46.5	24.5	
2:00	126	610	270	130	25.0	46.5	24.5	
2:30	126	610	270	130	25.0	47.0	25.0	
13 HOURS WITH ONE-HALF LOAD.								
2:30	126	400	270	130	25.0	47.0	25.0	
3:00	126	400	270	130	24.5	46.0	24.0	
3:30	126	400	270	130	24.5	45.5	24.0	
4:00	125	410	270	130	24.0	44.0	24.0	
4:30	126	410	270	130	24.5	44.0	24.0	
5:00	126	410	270	130	24.5	44.0	24.0	
5:30	125	400	270	132	24.0	44.0	24.0	
6:00	126	400	270	135	24.0	44.0	24.5	
6:30	126	400	270	130	24.0	44.0	24.5	
7:00	126	410	270	135	24.0	44.5	24.5	
7:30	125	390	270	130	24.5	44.5	24.0	
8:00	126	440	270	130	24.5	43.5	24.0	
8:30	125	405	270	130	24.0	43.0	25.0	
9:00	125.5	390	270	130	24.0	41.0	25.5	
9:30	126	390	270	130	24.0	41.0	25.0	
10:00	126	430	270	130	24.0	41.0	25.0	
10:30	126	420	270	130	24.0	42.0	25.5	
11:00	126	420	270	130	24.0	43.0	26.0	
11:30	126	420	270	130	24.0	43.0	27.0	
12:00	126	420	270	130	24.5	43.0	26.0	
12:30	124	440	270	127	25.0	42.5	27.0	
1:00	123	420	270	127	25.0	42.5	27.0	
1:30	123	460	270	127	26.0	42.0	27.0	
2:00	126	420	270	127	26.0	42.0	27.0	
2:30	124	425	270	127	25.0	42.0	27.0	
3:00	125	400	270	126	25.5	43.0	26.0	
3:30	126	364	270	126	25.5	44.0	26.0	3
14 HOURS WITH ONE-QUARTER LOAD.								
3:30	126	200	270	126	26.5	44.0	26.0	
4:00	126	230	270	126	26.0	44.5	26.0	
4:30	124	210	270	126	26.0	44.0	26.0	
5:00	125.5	220	270	130	26.0	43.0	26.5	
5:30	125	240	270	130	25.0	42.0	26.0	
6:00	124	240	270	128	26.0	42.0	26.0	
6:30	124	240	270	128	26.0	41.5	26.5	
7:00	124	236	270	130	26.0	41.5	26.5	
7:30	125	200	270	130	25.0	42.0	26.0	
8:00	125.5	200	270	130	25.0	42.0	25.0	
8:30	126.	210	270	130	25.0	42.0	25.0	
9:00	126	210	270	130	25.0	41.5	24.5	
9:30	125	200	270	128	25.5	41.5	24.5	
10:00	125.5	200	270	132	25.0	40.5	24.0	
10:30	125	210	270	132	25.0	40.5	24.0	
11:00	124	196	270	130	26.0	39.5	24.0	
11:30	125	210	270	128	25.0	39.5	24.0	
12:00	125	200	270	125	26.0	39.0	24.0	
12:30	126.5	210	270	129	26.0	39.0	24.0	
1:00	126	200	270	128	26.0	39.0	23.5	
1:30	126	208.5	270	129	23.0	38.5	23.5	4
2:00	126	210	270	129	23.0	38.5	23.5	
2:30	126	196	270	129	23.0	39.0	23.5	
3:00	126	215	270	129	24.0	38.0	23.0	
3:30	125	200	270	130	26.5	38.0	23.0	
4:00	126	210	270	130	25.5	38.0	23.0	
4:30	126	210	270	130	25.5	38.0	23.0	
5:00	125	198	270	130	25.5	38.0	23.5	
5:30	125	200	270	130	25.5	38.0	23.5	
6 HOURS WITH FULL LOAD.								
5:30	126	800	271	130	25.5	36.0	23.0	
6:00	125	810	271	132	25.5	40.0	23.0	
6:30	125	820	271	130	25.5	41.5	24.0	

U. S. S. CALIFORNIA — LOG OF 48-HOUR SERVICE TEST

Time	Volts	Amperes	R.P.M.	Steam	Vacuum	Temp. Field Coils	Temp Air	Card No.
6 HOURS WITH FULL LOAD, (Continued)								
7:00	126	800	271	130	25.5	44.0	24.0	
7:30	126	820	271	130	25.5	46.0	24.0	6
8:00	126	[illegible]	271	130	25.5	48.0	25.0	
8:30	125	825	271	130	25.0	49.0	25.0	
9:00	125	780	271	130	24.0	49.0	25.0	
9:30	125	805	271	132	24.5	48.0	25.0	
10:00	125	810	271	130	24.5	48.0	25.0	
10:30	125	845	271	130	24.0	47.0	25.0	
11:00	125	810	271	130	26.0	47.0	26.0	
11:30	125	800	270	130	25.0	47.0	26.0	6

Data observed during the 6-Hour Full Load Run, to determine the temperature of Field Coils, by rise of resistance.

Time	Temp. Series Shunt C°	Shunt E.	Shunt I.	Shunt R.	Average Room Temp.	Coil Temp. Rise	Temp. of Field Coils by rise of resistance
5:30	62.5	81.0	8.36	9.70	23.25	36.75	60.00
6:00	81.5	93.6	9.55	9.70	23.26	28.94	52.20
6:30	84.5	94.0	9.50	9.08	23.50	30.45	53.95
7:00	85.5	95.6	9.65	9.20	23.63	31.00	55.63
7:30	86.5	97.0	9.80	9.90	24.30	31.60	55.60
8:00	86.5	98.0	9.90	9.90	24.50	31.00	55.50
8:30	86.5	96.0	9.70	9.90	24.75	30.75	55.50
9:00	69.0	98.0	9.90	9.90	25.00	30.45	55.45
9:30	67.5	96.0	9.70	9.90	25.00	30.45	55.45
10:00	67.0	90.0	9.10	9.90	25.25	30.15	55.40
10:30	71.0	89.0	9.00	9.90	25.50	29.90	55.40
11:00	75.0	90.0	9.10	9.90	25.75	29.30	55.35
11:30	76.0	90.0	9.10	9.70	26.00	29.30	55.30

DATA OBSERVED IMMEDIATELY BEFORE SHUTTING DOWN AT END OF RUN.	
Temperature of Field Coils, (Deg. C.)	47.00
" " Series Shunt, " "	75.00
" " Field Rheostat, " "	78.00
" " Gen. Outboard Bearing " "	45.00
" " Eng. Main Bearing, L.P. End, " "	32.00
" " " " " Middle, " "	30.00
" " " " " H.P. End, " "	41.00
" " Generator Switches, " "	31.00
" " Pole Tips, " "	30.00
Did Brushes or Commutator require unusual care?	No
Sparking during the 6-Hour Full Load Run?	No

DATA OBSERVED IMMEDIATELY AFTER SHUTTING DOWN AT END OF RUN.	
Resistance of Shunt Field Coils, (Ohms)	10.00
Temperature of Armature Core, (Deg. C.)	61.00
" " " Binding Wire " "	61.00
" " Commutator " "	47.00
Condition of Commutator?	Good
" " Brushes?	Fair
" " Bearing Metal, Engine?	Fair
" " H.P. Valve and Liner?	Good
" " L.P. " " " [illegible]	Good
" " Cylinders?	Good
Overheating of Bearings?	No
Pounding or vibration of engine noted?	No

INSULATION RESISTANCE, (HOT).	
Voltmeter Resistance, (Ohms)	500,000.00
Line E.M.F.	200.00
Armature to Shaft, (Megohms)	4.60
Frame to Bedplate, "	1.45
Shunt Field to Frame, "	2.50
Series " " " "	2.10
Shunt " " Series, "	2.65
Positive Brush Studs to Ground "	2.10
Negative " " " " "	2.10

Remarks

Circuit Breaker out at 2.40 during the [illegible] run, caused by [illegible]. At 3.40 on the full load run the circuit breaker went out again, caused by a sudden [illegible]. Unsteady steam pressure is caused by sticky reducing valve; the valve has since been overhauled and the faults remedied.

DATA OBSERVED AND TAKEN DURING THE PRELIMINARY SHOP TESTS.

Rev.	Steam	Vacuum	Arm. Volts	Field Volts	Field Amperes
INTERNAL CHARACTERISTIC.					
270	[illegible]	[illegible]	.60	[illegible]	[illegible]
270	[illegible]	26.5	24.00	[illegible]	[illegible]
270	125	27.5	48.00	[illegible]	[illegible]
270	[illegible]	26.5	74.00	39.00	[illegible]
270	125	26.5	100.00	56.00	[illegible]
270	[illegible]	26.5	120.00	[illegible]	[illegible]
270	125	26.5	140.00	91.00	[illegible]
270	125	26.5	150.00	115.00	[illegible]
270	125	26.5	160.00	145.00	[illegible]
270	[illegible]	26.5	162.50	[illegible]	[illegible]
270	[illegible]	26.5	170.00	164.00	[illegible]
270	126	26.5	150.00	[illegible]	11.25
270	126	26.5	140.00	76.00	10.12
270	[illegible]	26.5	125.00	76.00	[illegible]
270	[illegible]	26.5	100.50	[illegible]	[illegible]
270	[illegible]	26.5	75.00	37.00	[illegible]
270	[illegible]	26.5	48.00	24.00	[illegible]
270	[illegible]	26.5	27.60	14.00	[illegible]
270	125	26.5	.60	[illegible]	[illegible]

See curves

WATER CONSUMPTION TABLE.

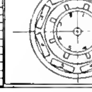
Pounds Water per hour.

Load	Total Water	I.H.P. Hour	E.H.P. Hour	K.W. Hour
0	690			[illegible]
25 %	1,160	46.40	34.60	[illegible]
50 %	1,470	[illegible]	24.20	[illegible]
75 %	[illegible]	30.46	22.45	[illegible]
100 %	2,960	30.80	22.20	[illegible]
133 %	3,700	27.75	20.70	17.70

See curves

ELECTRICAL AND MAGNETIC BALANCE.

Brushes	Volts Bet.	Coil E.	Coil I.	Rev.	Field Coil No.
all	123.1	73.81	8.00	276	all
1-2	124.5	8.76	8.00	275	1
2-3	123.5	9.28	8.00	275	2
3-4	121.5	9.20	8.00	275	3
4-5	122.5	9.28	8.00	275	4
5-6	124.0	9.06	8.00	276	5
6-7	123.5	9.20	8.00	275	6
7-8	122.0	9.12	8.00	276	7
8-1	123.5	9.12	8.00	275	8



TESTS OF ELECTRIC PLANT
U.S.S. CALIFORNIA GEN. SET NO. 1
Type MP 4-100-275-800-125 Volts
Engine [illegible] Gen. No. [illegible]
Steam 125 lbs. Vacuum 25 in.
L. St D. ROYLANCE
CONSULTING AND CONTRACTING ELECTRICAL AND MECHANICAL ENGINEER
SAN FRANCISCO, CALIF.

rise of temperature to be referred to a standard room temperature of 25 deg. C. and normal conditions of ventilation.

The generators must be capable of operating for a period of two hours carrying one and one-third times its rated full load, and no part shall heat to such a degree as to injure the insulation. Generators of same size and manufacture must be capable of operating in parallel, the division of the load to be within 20 per cent throughout the range. The magnetic leakage at full load shall be imperceptible at a horizontal distance of 15 feet.

On the completion of the vessel and before acceptance, the insulation resistance of all circuits is tested out and must conform to the following specifications: Circuits must be connected up to all their outlets and show an insulation resistance of not less than 1 megohm between circuits, and from each circuit to ground. Searchlight feeders and motor feeders must show an insulation resistance of not less than 5 megohms, the circuits not being connected up.

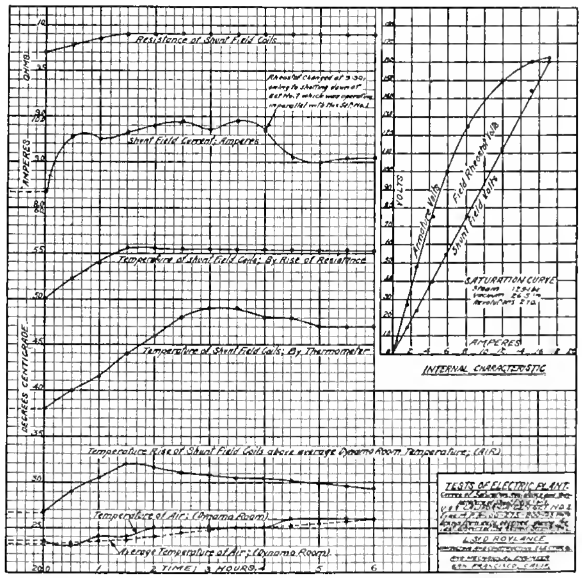
A pressure of 125 volts is used for measuring the insulation resistance of all circuits which operate at the dynamo voltage. Interior communication circuits not included in the above are tested by means of a standard portable testing set.

The generating sets, wiring appliances, fixtures, accessories, etc., must pass tests required by their respective specifications. The generating set specifications are somewhat varied and exacting. The sets on completion are given thorough shop tests, and after being installed and before acceptance on completion of the vessel, they are again subjected to a 48-hour service test.

The following log sheets with curves, etc., includes test data observed during the preliminary shop tests and which was not again observed during the 48-hour service test on board the ship. The test herein shown is of generating set No. 1 which is of 100 k. w. capacity and is typical of tests of the other 50 and 100 k. w. generating sets.

The tests were started and continued without intermission until completed. The loads were obtained from the ship's installation of incandescent lamps, ventilation and power motors, and also by water rheostate located on the dock.

All data and observations were recorded in the log sheets as shown in the various figures.



Sets Nos. 1 and 2 were taken as types of their respective sizes (50 and 100 k. w.), and data which is considered of interest and which was observed during the perliminary shop tests, has been embodied and curves plotted. During the 6-hour full load run, data was observed and taken to ascertain the maximum heating of the field coils, when subjected continuously to normal current; it being questioned at the time whether the coils had reached their maximum temperature at the end of the 4-hour heat run. Curves plotted from the data are shown. On the log

sheet tables are shown of internal characteristic; electrical and magnetic balance and water consumption; and curves of water consumption and internal characteristic plotted from same are also shown in the accompanying figures.

Indicator diagrams taken during the test and efficiency curves plotted from same are shown, together with curves of compounding and revolutions. The efficiency curves of the set show the engine, generator and combined efficiencies. Curves of parallel operation of three generating sets likewise appear herewith .

The engine regulation tests under various load, steam and exhaust conditions for generating sets Nos. 1 and 4, being 50 and 100 k. w. respectively, follows:

THE SALESMAN'S CREED.

The November issue of the "Engineering Quarterly" of the University of Missouri contains an interesting paper by Professor H. Wade Hibbard, of the mechanical engineering faculty of the university, entitled "The Science of Engineering Salesmanship." After a discussion of modern industrial and commercial methods the writer takes up the personal qualities desirable for salesmanship and analyzes the elements which enter into a sales transaction. Manufacturers, it is stated, who once said salesmen are born, not made, are now beginning to make them. Principles of selling are investigated and brought to uniform practice. "The day of the crafty, tricky, glib, ill-educated, loud and intemperate salesman is gone. Now he must be honest and have a reputation for honesty, be an expert in evidence, a trained logician, well educated and able to meet his customers on their own ground, of good health that his mind may be alert, and personally attractive, acquainted with the practical physiology of typical customers, able to give proofs so pointedly that the purchaser can be brought quickly to the closing of the sale." The paper concludes with the following "Salesman's Creed":

"I believe in the goods I am selling, in the firm I am working for, and in my ability to get 'results.'

"I believe that honest goods can be sold to honest men by honest methods.

"I believe in working, not exacting; in laughing, not weeping; in boosting, not knocking, and in the pleasure of selling goods.

"I believe that a man gets what he goes after; that one order to-day is worth two orders to-morrow, and that no man is down-and-out until he has lost faith in himself.

"I believe in courtesy, in kindness, in generosity, in good cheer, in friendship and honest competition.

"I believe there is an order somewhere for every man ready to take one.

"I believe I am ready—right now."

U. S. S. CALIFORNIA—LOG OF 48-HOUR SERVICE TEST.

DYNAMO ENGINE REGULATION TESTS.

Set No.	Steam	Vacuum	Amperes	Rev.	Volts	Jump Revolutions High	Low	Steady	Change	% Change	Jump Volts High	Low	Steady	Change	% Change	Load, Steam and Exhaust Conditions
1.	100	21.5	800	273	125	282		271	2	.732	137		127	12	9.60	Full load to no load, 100 lbs. steam,
	100	21.5	0	271	127		263	273	2	.738		115	125	12	9.45	vacuum exhaust.
	125	22.0	800	271	125	282		270	1	.369	140		127	15	12.00	Full load to no load, 125 lbs. steam,
	125	22.0	0	270	127		264	271	1	.370		118	126	9	7.10	vacuum exhaust.
	150	21.5	800	271	125	284		273	2	.738	139		130	14	11.20	Full load to no load, 150 lbs. steam,
	150	21.5	0	273	130		262	271	2	.732		117	123.5	13	10.00	vacuum exhaust.
	127	22.5	800	271	125			270	1	.369			126	1	.80	Full load to 20% full load, gradually,
	127	22.5	170	270	126			271	1	.370			122.5	3.5	2.78	125 lbs. steam, vacuum exhaust.
	125	23.0	800	272	125	280		271	1	.368	139		129	14	11.20	Full load to 20% full load, one step,
	125	23.0	170	271	129		264	272	1	.369		120	124	9	6.98	125 lbs. steam, vacuum exhaust.
	100	0.	720	276	125	282		274	2	.725	138		129	13	10.40	90% full load to no load, 100 lbs.
	100	0.	0	274	129		265	276	2	.730		118	125	11	8.54	steam, atmosphere exhaust.
	125	0.	800	276	125	284		274	2	.725	140		130	15	12.00	Full load to no load, 125 lbs. steam,
	125	0.	0	274	130		265	276	2	.730		119	126	11	8.47	atmosphere exhaust.
	150	0.	800	277	125	282		274	3	1.080	141		129.5	16	12.80	Full load to no load, 150 lbs. steam,
	150	0.	0	274	129.5		265	277	3	1.095		118	125	11.5	8.88	atmosphere exhaust.
4.	100	21.5	400	346	124.5	353		351	5	1.440	132		128	13.5	10.85	Full load to no load, 100 lbs. steam,
	100	21.5	0	351	128		343	346	5	1.420		120	124.5	8	6.25	vacuum exhaust.
	125	22.0	400	347	123	353		352	5	1.440	132		125	9	7.32	Full load to no load, 125 lbs. steam,
	125	22.0	0	352	125		342	347	5	1.420		117	123	8	6.40	vacuum exhaust.
	150	21.5	400	348	125	354		351	3	.862	131		127.5	6	4.80	Full load to no load, 150 lbs. steam,
	150	21.5	0	351	127.5		342	348	3	.855		121	125	6.5	5.10	vacuum exhaust.
	125	22.5	400	347	122.5			352	5	1.440			124	1.5	1.22	Full load to 20% full load, gradually,
	125	22.5	80	352	124			347	5	1.420			122.5	1.5	1.21	125 lbs. steam, vacuum exhaust.
	125	23.0	400	347	123.5	353		351	4	1.150	129		126	2.5	2.02	Full load to 20% full load, one step,
	125	23.0	80	351	126		344	347	4	1.140		120	123.5	6	4.76	125 lbs. steam, vacuum exhaust.
	100	0.	360	346	125	352		351	5	1.440	134		130	9	7.20	90% full load to no load, 100 lbs.
	100	0.	0	351	130		342	346	5	1.420		122	125	8	6.15	steam, atmosphere exhaust.
	125	0	400	347	125	353		351	4	1.150	134		129	9	7.20	Full load to no load, 125 lbs. steam,
	125	0.	0	351	129		344	347	4	1.140		120	125	9	6.98	atmosphere exhaust.
	150	0.	400	348	125	354		351	3	.862	134		126	1	.80	Full load to no load, 150 lbs. steam,
	150	0.	0	351	126		345	348	3	.855		118	125	8	6.35	atmosphere exhaust.

The following is a summary of cold and hot temperatures and resistances of generating sets Nos. 1 and 4. taken at the beginning and end of a full load heat test:

TEMPERATURE AND RESISTANCE OF GENERATING SETS.

GENERATOR NUMBER.	1		4	
TEMPERATURES.	C	H	C	H
Armature	20.	54.	23.	55.
Commutator	20.	52.	23.	54.
Shunt Field Coils	20.	50.5	23.	44.
Series Field Coils	20.	50.5	23.	44.
Series Shunt	20.	68.5	...	...
Field Rheostat	24.	57.	25.	66.
Generator Switches	21.5	29.	26.	32.5
Generator Pole Tips	20.	42.	23.	45.
Generator Outboard Bearing	20.	44.	23.	44.
Engine Main Bearing, L. P. end	20.	38.	23.	47.
Engine Main Bearing, Middle	20.	42.	...	...
Engine Main Bearing, H. P. end	20.	42.	23.	43.
Air at Machine	20.	26.5	23.	28.
RESISTANCE.				
Armature	.00448	.005035	.00567	.00634
Shunt Field Coils	8.74	10.15	7.88	8.56
Series Field Coils	.000748	.000838	.000925	.00100
Field Rheostat	9.65	....	26.8	......

NOTE—C: Cold Resistance observed before starting test.
H: Hot Resistance observed at end of full load run.

DISCUSSION

THE MULTIPLE ARCH DAM.

To the Editor:—In the Journal of Electricity, Power & Gas for December 25, '09, Mr. C. E. Grunsky, in commenting upon a dam built by Mr. J. S. Eastwood near Hume, Fresno County, California, states that the most economical arch is one which covers 60 degrees. This the writer fails to see.

The most economical arch would have a triangular cross section with maximum width at the foundation and zero width at the water surface. The amount of concrete in any arch is:

Area of cross section x 2 x mean radius x enclosed angle. We will have minimum of material when

$$\frac{d.\ \text{Amount of concrete}}{d.\ \text{Enclosed angle}} = o$$

By differentiating it can be shown, that this equation is satisfied, when the enclosed angle is 133° 34'.

As the top width of the dam cannot be zero, this angle will for a practical profile fall out somewhat smaller in the neighborhood of 120° as Mr. Eastwood has it. In short spans, however, it may very well be possible that the enclosed ang'e can be made smaller than 120° for maximum economy, but for special reasons.

A certain minimum thickness is always required for water-tightness and if the concrete has to be there it might just as well be loaded. Doubling the length of the radius, throws twice the strain on the concrete for the same span and cuts the enclosed angle nearly in half. Therefore if the concrete can stand the additional load it is economy to make the radius larger, thereby the enclosed angle smaller, but this is only a special case, the rule is that the enclosed angle has to be near 120° for maximum economy of material.

LARS JORGENSEN.

To the Editor: The idea of forming a masonry dam of a number of piers between which vertical arches convex upstream are sprung is not new. About 1800 such a dam was built in India to form the Meer Allum reservoir. This dam, which forms in plan a large arch about half a mile long, consists of 21 smaller arches which transmit the water pressure to solid-masonry buttresses. The greatest depth of water in this reservoir is about 50 feet. About 1898 a similar dam, having a maximum height of about 60 feet, was built across the Belubula River in New South Wales, to form a storage reservoir. Short descriptions of both of these dams are given in the fifth edition of my book on the "Design and Construction of Dams."

In preparing plans for a concrete dam at Ogden, Utah, which was to be 369 feet long and 105 feet high above the foundation, Henry Goldmark, M. Am. Soc. C. E., proposed to make the structure consist of piers 16 feet wide, placed 32 feet apart in the clear, which were to support inclined segmental arches. (See Trans. Amer. Soc. C. E. for December, 1897.)

Mr. George L. Dillman, M. Am. Soc. C. E., demonstrated mathematically, that a saving in material may be effected by building a dam of piers and arches (see his paper on "A proposed New Type of Masonry Dam" in Trans. Am. Soc. C. E., for December, 1902).

A few years ago I was asked to make calculations for a dam 160 feet high, of the type described above, viz.: piers joined by vertical arches. While I found that a saving of about 15 per cent might be effected by this construction, as compared with the usual uniform wall, adopted for a dam, I had some doubts as to how such a structure could be kept water-tight under a head of 160 feet, without going to too great an expense. The project was never carried out as the necessary means could not be secured.

A style of dam of the same order is the reinforced concrete dams, which are being built by the Ambursen Hydraulic Construction Company of Boston, Mass. These dams are made of buttresses, placed 12 to 15 feet apart, which are joined by a water-tight deck.

Mr. Eastwood gives a very interesting description of the first dam in the United States, so far as I know, that has been built of piers joined by vertical arches. I feel satisfied that some saving in material (probably 10 to 15 per cent), may result from adopting this type of dam, instead of the usual uniform wall, and more structures of this kind are likely to be built hereafter.

Whether this plan should be adopted for a high masonry dam is a question about which I do not feel quite sure, as the saving in masonry might be offset by the additional cost required to secure water-tightness.

E. WEGMANN.

CIRCULATION AND ADVERTISING CONTRACT MEETING OF TECHNICAL PUBLICITY ASSOCIATION.

The Technical Publicity Association held its December meeting on Thursday, the 9th, at the National Arts Club, No. 14 Gramercy Park, New York. After the usual informal dinner a lively discussion ensued over the subject of Circulation and the introduction of the proposed uniform advertising contract for trade papers. Mr. F. H. Gale, charge of advertising for the General Electric Company, Schenectady, N. Y., took his turn at presiding during the debate. The attendance was large, and the participation in the discussion of the prominent technical advertising men and trade paper publishers who were present made the session a most profitable one.

William H. Taylor, treasurer and manager of the Iron Age, opened the discussion, giving it as his opinion that the true measure of a publication is its editorial quality. He said there was no more discriminating class of people in existence than subscribers to a publication.

Mr. Taylor said that advertisers should put themselves in the proper frame of mind in approaching the circulation question. He granted their perfect right to know how many and who read a publication, and he said no good publication refuses such information. The trouble has been, he said, not that the publishers have been ashamed of their circulation, but that wrong deductions may be made when a reputable publisher's statement is placed in comparison with an untruthful one. Mr. Taylor made the first public announcement of the circulation of the Iron Age.

C. S. Redfield, advertising manager Yale & Towne Mfg. Company, and president of the T. P. A. here explained how members considered the circulation statements of publishers, being in some cases absolute sworn statements, also the possibility of detecting the liars.

John McGhie of the American Machinist, told about the passing of old-time advertising solicitation in which the hypnotic eye played a prominent part, and said that after trying all other policies, publishers have learned that the truthful policy is the best. He said the advertiser buys reputation and editorial force quite as much as circulation.

F. R. Davis, of the General Electric Company, said that many publishers seemed to feel that advertising men know their own business, and tried to lead them into unprofitable contracts.

H. M. Sweatland, publisher of Automobile, said it was his purpose as a publisher to furnish maximum quantity, but that for a class paper to go beyond a certain quantity was simply to vitiate itself. A phenomenal solicitor, he said, once got a thousand subscriptions within a radius of 20 miles, but after two years only one more subscriber was on the list for that district than there was prior to his solicitation.

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

With this, the initial issue of 1910, which appears on New Year's Day, we take pleasure in wishing all our readers a "Happy New Year." From the many words of commendation received, we believe that our efforts during 1909, to make a bright and readable technical journal, recording the power progress of the West, have not been in vain. During the past year nearly twelve hundred pages of editorial matter have been published, the greater part of which appeared herein before it was published elsewhere. For the fifty-three numbers of 1910 many interesting and valuable articles are assured.

Hydrogen

The fledgling science of aeronautics is demanding cheaper hydrogen gas for the dirigible balloon. Hydrogen has more than seven times the lifting power of an equal volume of illuminating gas, which is often used for this purpose, as it is about one-half as heavy as air. But processes giving hydrogen as a waste product are few and far between. The action of sulphuric acid on iron is expensive, as the resulting bluestone is more cheaply produced by other methods. Electrolytic dissociation of water is used to advantage where the oxygen can also be utilized, as in the recent perfected process for cutting and welding metals by means of the oxygen and hydrogen blow-pipe. A company in Germany has recently perfected a process whereby it is proposed to furnish hydrogen at a cost of one dollar per thousand feet. This process involves the reaction between water gas and calcium carbide, when the latter is highly heated. All the constituents of the water gas, except the hydrogen, unite to form solid compounds, which allow practically pure hydrogen to be conducted to the holder. Thus has aviation brought new work to the electric furnace, in which is made the calcium carbide.

Electricity on a Man-of-War

There is no change in methods of warfare which has been more radical than that which has been quietly and unobtrusively wrought by electricity within the past decade. There is hardly a phase of the military art to which it has not been applied. Its many varied uses have become as indispensable in the army and navy as in our industrial and domestic lives. Imagine the great guns on our battleships and in our coast defenses being moved by hand-power, and their ammunition supplied by powder boys; note the helplessness of a battleship without searchlights; make communication as difficult and slow as it was before the invention of the telegraph and the telephone—and we would soon realize our dependence upon electricity for fighting. In facilitating means for warfare, electricity has done more to promote peace than all the congresses yet convened.

Nevertheless, there are few people who understand how and where it is used on board a man-of-war. We consequently feel justified in devoting the major portion of this issue to a detailed description of the electrical installation of an armored cruiser.

As will be noted, the present naval practice is to generate direct current at 125 volts and distribute on the two-wire system, current thus being supplied for lighting, power and communication. Aside from the tests of the generating machines, perhaps the most interesting part of the paper is its description of the various power applications, and their control. Of these, the most exacting requirements are those of the gear for revolving the gun turrets. When it is understood that these must be able to revolve uniformly at the rate of but one revolution for twenty-four hours, with seventy intermediate speeds between that and one revolution in three and one-half minutes, it is easy to comprehend the difficulties of applying electric power to this service, especially when the turret must be brought to full speed within ten seconds and stopped within five seconds.

PERSONALS.

Walter G. Niles of the Reierson Machinery Company of Portland, Oregon, is in San Francisco.

Joseph T. Wolfe, electrical engineer for the Tonopah Mining Company, was in San Francisco this week.

R. F. Oaks, president of the American Ever-Ready Company, left last Thursday on an extended trip to New York.

Charles F. Clayton, general superintendent of the Tuolumne Transmission Company, was in San Francisco this week.

W. J. Davis Jr., Pacific Coast engineer for the General Electric Company, left San Francisco on December 29th for the South.

W. J. Sussex of Wenatchee, Washington, has been made local consulting engineer for Fairbanks, Morse & Company at Seattle.

E. H. Corbett has offices in the Commercial Club Building, Portland, Oregon, with a complete line of gas appliances and gas works equipment.

E. A. Quinn has resigned as general superintendent for the Nevada-California Power Company at Goldfield, and will probably locate in San Francisco.

George Scarfe, superintendent of the Nevada district of the Pacific Gas & Electric Company, recently became a grandfather at the early age of forty-two.

H. R. Noack, manager of Pierson, Roeding & Co. addressed the Los Angeles Section, A. I. E. E. on "Aging of Insulators," on December 28, 1909.

H. W. Beecher, manager of the Seattle office of Chas. C. Moore &Co., Engineers, Inc., returned to Seattle this week after a brief stay in San Francisco.

F. V. T. Lee, assistant general manager of the San Francisco Gas & Electric Company, will return from an extended vacation to the Antipodes early next week.

P. F. Lane and W. H. Warren, formerly with the Pacific Telephone & Telegraph Company, have established the Southern Oregon Electric Company with headquarters at Medford, Oregon.

J. A. Herr, formerly with the Philadelphia and New York offices of the Sprague Electric Company, has joined the San Francisco offices of this company as specialist on flexible steel conduit and steel armored conductors.

John A. Britton, vice president and general manager of the San Francisco Gas & Electric Company, was recently chosen one of the committee of two hundred, to develop and finance the Panama Exposition to be held in San Francisco in 1915.

John Carter, chief engineer of the Crocker building, was presented last Tuesday with a silver dinner set by some of his friends among the stationary engineers of San Francisco in recognition of his good fellowship amongst his brother engineers.

P. M. Haight, well known in electrical circles as treasurer of the Sprague Electric Company, was recently elected president of the Electrical Trades Society of New York. Mr. Haight's experience in this line combined with enthusiastic ability bespeaks for the society a successful administration.

George A. White of the contracting engineering firm of White & Newcomb, Mexico City, is spending the Christmas holidays in San Jose. The firm of White & Newcomb has the contract for installing the plant of the celebrated Santa Gertrudas y Guadalupe Company at Pachuca, Mexico, besides many other plants of importance in the southern republic.

NEWS NOTES.

The Union Lumber Company of Fort Bragg are figuring on a 750 k. w. turbine.

Keeler, White & Co., on December 28th, shipped a complete wireless equipment, good for 500 miles, to Tahiti.

The Western Distillery at Agnews, Cal., ordered from the Western Electric Company, 75 k. w., Hawthorn d. c., engine type generator, with motor equipment and switchboard.

The General Electric Company recently shipped a 500 h. p Curtis turbine to the Honolulu Iron Works, to be installed by them for the Honolulu Plantation Company. The turbine is to be direct connected with a Byron Jackson pump.

Chas. C. Moore & Co., Inc., engineers, report the sale through their Seattle office of a 6000 h. p. steam plant to the British Columbia Electric Co. This is to be installed at Vancouver as an auxiliary to the hydroelectric plant of the company. Allis-Chalmers have the contract for the turbines, Chas. C. Moore & Co. supplying the boilers and all auxiliaries.

The Chas. L. Kiewart Co. of San Francisco recently installed for the Haight Street and Ashbury Heights Improvement Club, four flaming arc lamps, two Aurola and two Alba. The lamps were put in on trial on Haight street between Masonic avenue and the Park. They have proven highly satisfactory and the improvement club will immediately install 40 lamps in this district , putting eight lamps to a block.

The Holabird-Reynolds Company of San Francisco, Holabird-Reynolds Electric Company of Los Angeles and Holabird Electric Company of Seattle have been duly appointed as the Ohio Brass Company's exclusive sales agents for O-B Hi-Tension Porcelain Insulators in the States of California, Oregon and Washington. Pierson, Roeding & Company, with offices at San Francisco, Los Angeles and Seattle, will continue to be exclusive sales agents for overhead material, rail bonds, car equipment specialties and catenary material, including such special porcelain insulators as are used in catenary construction.

The Board of Public Works of Spokane, Wash., recently awarded a contract to the Allis-Chalmers Company of Milwaukee for the new municipal waterworks pumping station. This company is the same one which built the New York high pressure fire protection service and is now building a pumping plant for Niagara Falls. The equipment will consist of six single suction, horizontal shaft, two-stage centrifugal pumps driven by three 900 h. p., 2200 volt, 60 cycle, 3 phase induction motors. Ordinarily the pumps will operate in parallel, but for fire pressure they will be connected two in series. The pumps will have a 24-hour capacity per pair of 7,500,000 gallons against 430 feet head or 12,000,000 gallons against 260 feet. A three panel switchboard will carry the controlling apparatus.

The Whatcom County Railway & Light Company have under course of construction in the Pelton Water Wheel Company's San Francisco shops, a multiple wheel Pelton impulse unit of unique design, inasmuch as the wheel unit is to develop 3200 h. p. under a head of only 165 ft. The wheel unit direct connects to an electric generator running 200 r. p. m. Under these conditions six impulse runners are employed on one shaft, each runner being supplied with water through a double nozzle. Ultimately the head will be increased to 400 ft., at which time, four of the runners will be taken from the wheel unit, leaving it a twin runner equipment when it is still to develop 3200 h. p. By reason of the great difference in pressure under which the wheel will temporarily and ultimately operate, the unit is of particular interest and design. It replaces an Eastern-made turbine. The water at this plant is particularly gritty, rendering the life of the existing turbine equipment short. The current from this power station will be transmitted to Bellingham and the surrounding towns.

NEWS OF THE STATIONARY ENGINEERS

PREAMBLE.—This Association shall at no time be used for the furtherance of strikes, or for the purpose of interfering in any way between its members and their employers in regard to wages; recognizing the identity of interests between employer and employe, and not countenancing any project or enterprise that will interfere with perfect harmony between them.

Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the business of the Association, and at all times preference shall be given to the education of engineers, and to securing the enactment of engineers' license laws in order to prevent the destruction of life and property in the generation and transmission of steam as a motive power.

SAN FRANCISCO NO. 1.

Number 1 was favored with a visit from Bro. Waring of Fresno No. 7, who made some favorable remarks. The educational committee was granted power to provide a series of lectures on various engineering appliances from the many firms who desire to send their representatives to our meetings to exhibit their goods and endeavor to explain the merits of same, which no doubt will prove very instructive and interesting. L. H. Honigbaum, P. G. Burns, and Chas. Bankey submitted problems for discussion before the members present. On Tuesday evening, December 14th, the N. A. S. E. Club of San Francisco, gave a theater party at the Orpheum Theater. Seats were reserved in the front row of the balcony, after enjoying the performance the members repaired to an adjoining cafe, where refreshments were served and story telling and speeches were in order. At the next meeting of the club, which will be held on Tuesday evening, January 11th, business only will be transacted. P. L. Ennor is president, Chas. Dick is treasurer and H. W. Noethig is secretary, 816 York street.

PRACTICAL MECHANICS.

In a recent issue of the Journal it was announced that a series of papers would be given in this department covering some subject of importance of interest to mechanical or steam engineers. The subject first to be presented is indicated by the title of this article. In considering the broad field embraced by the science of mechanics as applied to machines it is difficult to make a selection which may be best suited to the individual needs of a majority of our mechanical department readers. After some deliberation, however, it has been decided to take up the various principles of mechanism involved in simple machines, and then to consider the application of these principles in the mechanics of the steam engine; this example being probably the most familiar and its study the most valuable to the steam engineer. In working out the design, drawing and specifications for a required machine definite factors have to be completely determined. First the form, which factor is governed by the work the machine is intended to do and by the external limitation imposed upon it; Second, the strength, a factor involving knowledge of the strength of materials and their wearing features; and third, the motions of the various parts. It is with this factor of motion that the principles of mechanism have to do.

The principles of mechanism are in reality the application of principles of kinematics—that branch of mechanics which deals with motion without reference to the cause producing it; several elementary combinations of mechanism sometimes being involved.

A machine may be defined as a combination of fixed and moving parts or devices so disposed and connected as to transmit or modify force and motion to the end that some useful result may be secured. The fixed parts constitute the frame or supports for the moving parts. The moving parts constitute a train or trains of mechanism.

A train of mechanism may be primary or secondary; the former being supported directly by the frame, and the latter by other moving parts.

All the moving parts may be regarded as mechanical devices and classified as follows:

First—Revolving shafts.

Second—Revolving wheels or cams with or without teeth.

Third—Rods or bars with reciprocating or vibrating motion or both.

Fourth—Flexible connectors depending upon friction.

Fifth—Flexible connectors independent of friction.

Sixth—A column of fluid in a pipe.

Trains of mechanism consist of combinations of the above devices. The least number of such combinations necessary to secure a desired modification of force or motion in a given case, is called an elementary combination.

A thorough systematic and comprehensive table of these elementary combinations was first arranged by Professor Robert Willis of Cambridge, England, and it is here given in full as the best means of showing the scope of our work.

In general then this will constitute our scheme of progress although certain digressions will be made from this fixed order of considering the topics, and where advisable in cases of more common application as e. g. gearing, belting, etc., the investigation will be made more complete than in the less useful combinations. For certain reasons, the order of procedure will not be in exact accordance with the above outline.

Our next paper will be concerned with the technical names and terms embraced by our study and with an introductory investigation into the various kinds of motion with which we shall be concerned in dealing with the various elementary combinations.

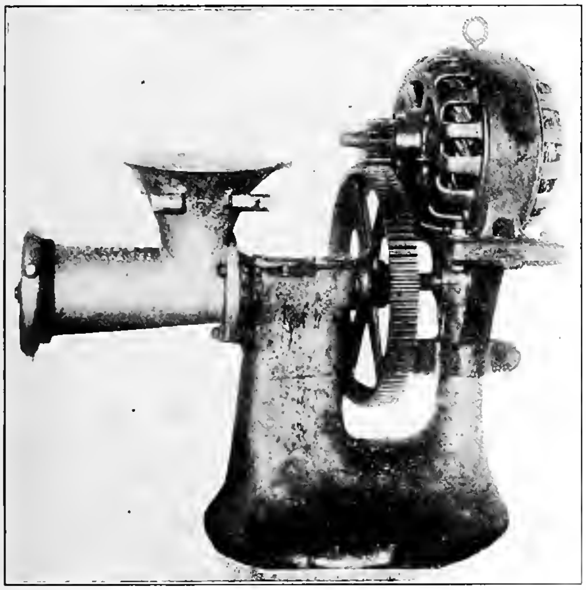
SYNOPTICAL TABLE OF THE ELEMENTARY COMBINATIONS OF MECHANISM.

Mode of transmission of motion.	Directional Relation Constant. Velocity-ratio, Constant.	Directional Relation Constant. Velocity-ratio, Varying.	Directional Relation Changing Periodically. Velocity-ratio, Constant or varying.
I. By rolling contact.	Rolling cylinders, cones and hyperboloids; pitch-circles of circular gear-wheels and sectors.	Pitch-lines of non-circular gearing, complete or sectoral.	Pitch-lines for mangle-wheels and mangle-racks; limited alternate motions.
II. By sliding contact.	Tooth-curves; segmental cams; screws; worm gearing.	Tooth-curves for non-circular gearing; cams; pin and slotted lever; irregular worm gearing; stop motions.	Cams in general, pin and slotted lever; double screw; swashplate; escapements.
III. By wrapping connectors, or belt gearing.	Band or belt and pulleys; chain and sprocket-wheel.	Cam-shaped pulley and belt; fusee and chain or cord.	Cam-shaped pulley and lever, or tightener; treadle motion.
IV. By link-work.	Equal cranks with link; lever with proportional links; bell-crank and links.	Equal cranks with link; unequal cranks with link; Hooke's universal joint.	Crank or eccentric and pitman; ratchet-wheels and clicks; unequal cranks and link.
V. By reduplication.	Cord and pulley; pulley-blocks with parallel ropes or chains.	Pulleys, with rope or chain not parallel.	

INDUSTRIAL

A COMPACT MOTOR-DRIVEN MEAT-CHOPPING MACHINE.

A striking example of the simplicity, convenience and efficiency of electric motor drive is the application shown in the illustartion, a 10 h. p. alternating current motor gear connected to a large meat chopper. This machine has a capacity for cutting and recutting 1500 pounds of beef three times per hour, and 3000 pounds of pork twice per hour. The compact drive secured by mounting the motor on the chopper frame has the added advantage of lifting the electrical equipment above the floor; always wet and more or less greasy in a sausage room. Besides the protection from dirt and grease thus afforded the motor windings and parts, virtually no space is occupied by the driving apparatus. The improved sanitary conditions as well as efficiency secured by avoiding moving belts and shafting are important results of employing electric drive in the preparation of food stuffs. The self-contained construction of the present application prevents the stirring up of dust or foreign particles in the chopping room.



Motor Driven Meat Chopper.

Gear drive has also worked a considerable economy in operation, for, while the type of machine illustrated ordinarily requires 10 h. p. when belt-driven, it has been found to take only 7½ electrical h. p. with the spur transmission shown. This economy of power, as well as the low cost of the installation, is perhaps the strongest point in favor of this method of applying electric power, although the convenience, compactness, simplicity and cleanliness of this drive should not be overlooked.

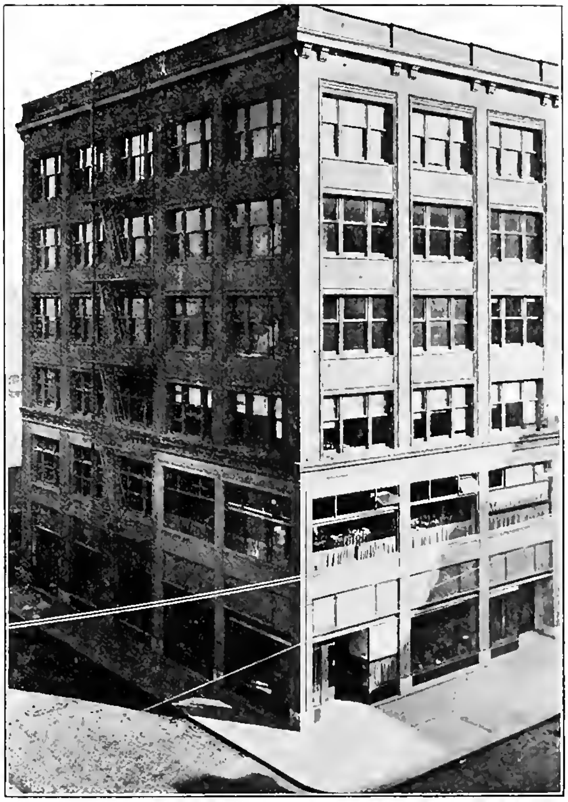
The mahine illustrated is a No. 66 Enterprise chopper, and was equipped with a Westinghouse type "CCL" three-phase induction motor for the Ziemsen Butchers' Supply Company, 2855 Archer avenue, Chicago, Ill.

ANOTHER QUICK SWITCHBOARD ORDER.

A fire at Bass, Michigan, destroyed the switchboard of the Bass Telephone Company. The Kellogg Switchboard & Supply Company received the order at 10:35 Friday, November 26th, and shipped the board complete on the first train Saturday, for Bass, which left at 10:30 a. m. Prompt service and shipments are important features of the Kellogg Switchboard & Supply Company's sales service for operating companies.

REORGANIZATION OF SAN FRANCISCO OFFICES WESTINGHOUSE ELECTRIC & MFG. CO.

The Westinghouse Electric & Manufacturing Company is just completing a scheme of interior office arrangement, which will not only greatly facilitate the handling of the company's extensive business but will prove a source of great convenience to its customers. The company occupies the entire first aud second floors and the basement of the Electrical Building at 165 Secoud street, San Francisco.



San Francisco Offices Westinghouse Electric & Mfg. Co.

Following is a synopsis of the location of the various departments. On the second floor are to be found: The manager's office and executive staff, the chief consulting engineer's office, the treasury or collection department, the railway and lighting department, the isolated plant, mining and dredging equipment department, the erection department.

The San Francisco district manager has general charge of the company's interest in the State of Nevada and throughout California as far south as the 35th parallel, or in reality as far as Bakersfield—the southern portion of the State being handled by the Los Angeles office. The treasury department has charge of the company's collections throughout the entire Pacific Coast west of the Rocky Mountains. The railway and lighting department has charge of all negotiations involving railway equipments or large central station projects. The isolated plant, mining and dredging equipment department has the handling of the electrical requirements in such negotiations, while the erecting department consists of a corps of expert erecting and installing engineers under the direct supervision of the manager, but also closely in touch with the factory erecting department.

The first floor is given over to the industrial and power

department, the detail and supply department, the incandescent lamp department, and the correspondence department.

The industrial and power department is concerned entirely wtih motors and their various applications. Controlling and auxiliary devices incidental to motor installation as well as generating equipment for industrial plants are handled by this department, there being well defined territorial lines for the various salesmen. The detail and supply department (as the name implies) is concerned entirely with the sale of the company's various details and supplies, and is likewise territorially divided among the various salesmen.

The incandescent lamp department is responsible for the sale of the Westinghouse Lamp Company's product. The lamp stock is carried in the basement of the building, so that prompt city delivery as well as convenient inspection can be made.

The correspondence department has charge of the entire machinery stock carried at Emeryville, and looks after all requisitions, shipments and orders. All correspondence with the factory at East Pittsburg having to do with shipments, stock or delivery of apparatus is done by this department. The company's extensive files and records are also handled by this department. At the company's Emeryville warehouse there is (in addition to the regular San Francisco force) a repair shop equipped with all necessary tools and apparatus for the speedy repair of electrical machinery, and an efficient corps of winders and machinists always are available.

TELEPHONE TRAIN DISPATCHING—NORFOLK & WESTERN RAILROAD.

The Norfolk & Western Railroad has recently placed orders for four complete telephone train dispatching circuits from Norfolk to Crewe, 27 stations, 130 miles; Crewe to Roanoke, 33 stations, 126 miles; Williamson, West Virginia, to Portsmouth, Ohio, 22 stations, 113 miles; and Portsmouth, Ohio, to Columbus, Ohio, 22 stations, 100 miles. These circuits, in addition to the two circuits now in operation between Roanoke and Bluefield and between Bluefield and Williamson, West Virginia, will complete the telephone train dispatching equipment for the entire main line between Norfolk and Columbus, Ohio, about 700 miles with about 125 stations equipped. The telephone apparatus for all these circuits was purchased from the Western Electric Company, the manufacturer of the standard "Bell" telephones used by the entire Bell system. Mr. W. C. Walstrum, superintendent of telegraph, reports that the two circuits now in operation are giving excellent service.

PRINTING PRESS CONTROLLERS.

The General Electric Company has developed a complete line of CR controllers designed to meet the requirements and severe service of small direct-current electrically operated printing presses. In their design special attention has been given to such necessary features as no-voltage protection, overload protection, push button stop and jog, ruggedness of construction, and accessibility.

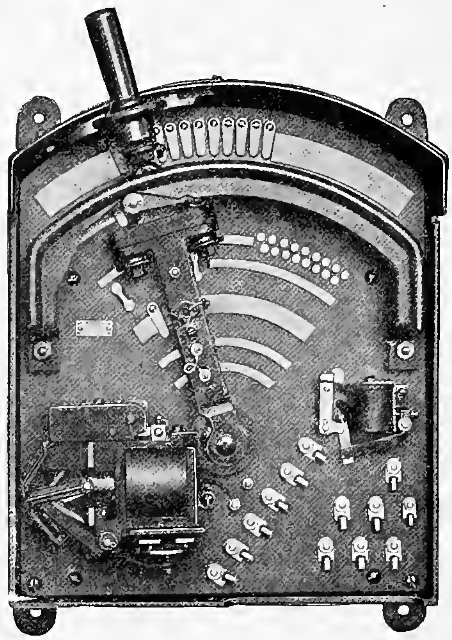
All controllers in this line have no-voltage protection. This consists of a contactor mounted in the lower left-hand corner of the slate front. The CR 169 has been designed so that upon failure of voltage the starting arm returns automatically to the off position. In addition, the controller arm is provided with a movable armature which may be adjusted so that the motor can be run only at a certain predetermined speed. All the other controllers of this line have been so designed that the contactor opens when the voltage fails and the contactor cannot be closed until the controller handle has been returned to the off position.

Since the armature circuit is made and broken by the contactor and not on the switch contacts, there is no arcing on the contacts. This eliminates the burning of the contacts which would necessarily result in roughening the surface, causing imperfect contact and their rapid destruction of the contact segments. The contactor is provided with a strong magnetic blow-out which extinguishes any arc that may result when the armature circuit is opened.

When the overload release is supplied in addition to the no-voltage release, it is so connected that when it operates it will de-energize the contactor coil, opening the contactor and thus breaking the armature circuit.

In many installations it is desirable to have push buttons located at various points around the press for stopping the motor, or for "inching" the press when necessary. Some of the controllers have, therefore, been designed to have both push button stop and jog, while others have the stop feature only.

If the push button is closed while the motor is not in operation the contactor will close, providing the switch is in the starting position, completing the armature circuit through the regulating resistance. This will start the motor which



Printing Press Controller with Cover Removed.

will run very slowly, as long as the push button is held closed. If the push button is closed while the motor is running, the contactor coil will be de-energized, thereby opening the motor circuit and stopping the motor. The same push button can, therefore, be used for jogging or stopping the motor. Each controller which has the stop and jog feature is furnished with two buttons; but any number of buttons may be installed.

Standard Form P resistance units are used throughout. In the controllers having a field regulating resistance, the units are assembled upon the back of the slate front, while the armature resistance, whether for starting or regulating duty, is assembled in a separate box. When a dynamic brake is supplied the resistance is in most cases external, but in some controllers it is self-contained.

The controllers are provided with renewable segments for armature control, while button contacts are used for field control.

The starting resistance is designed for starting duty only while the armature regulating resistance is designed for continuous operation, as various speed changes are obtained by varying the amount of resistance in the armature circuit.

NEWS NOTES

FINANCIAL.

PASADENA, CAL.—Sierra Madre is considering an issue of $100,000 bonds for the purchase of the Sierra Madre water plant, the owners of which have offered to sell to the city for $96,000.

RENTON, WASH.—The city of Renton has decided to issue bonds in the sum of $12,000 for the completion of its new water supply system which Mayor Benjamin Ticknor stated would be completed in thirty days.

LOS ANGELES, CAL.—The Board of Trustees of Calexico are arranging for a new municipal water system for which $30,000 bond were recently voted. New mains will be laid, three reservoirs built and an air pressure tank installed.

SANTA ANA, CAL.—The town of Newport Beach has voted bonds of $10,000 for water and $25,000 for gas. Proceeds will probably be utilized in buying the water plant and system now owned by J. H. Sharps, also the gas plant of the Home Gas & Electric Company to be run as a municipal plant.

DAYTON, N. M.—The City Council passed resolution 3 calling an election to be held on January 11th to vote on the question of issuing and selling bonds in the sum of $15,000 for the purpose of creating a fund with which to erect and maintain a system of water works in this city.

INCORPORATIONS.

SPOKANE, WASH.—Brown Electric Company of Chelan, $500,000, by G. P. Brown, J. G. Kennedy and C. P. Bissett.

MARSHFIELD, ORE.—Union Traction & Terminal Company of Coos Bay has been incorporated with a capital stock of $100,000, by J. N. Blake.

HOQUIAM, WASH.—The Grays Harbor Interurban Company, has been incorporated with a capital of $500,000, by Eldridge Wheeler of Montesano.

LOS ANGELES, CAL.—Los Angeles Meter Co., capital stock $10,000, by William Shade, J. G. Orth, A. W. Ballard, J A. Greenwood and John Morris.

SEATTLE, WASH.—The Pacific X-RAY Coil Manufacturing Company has been incorporated with a capital of $10,000, by F. L. Heidrich, Eighth avenue S. and Adams street.

LOS ANGELES, CAL.—Lordsburg and San Dimas Gas Company, capital stock $50,000, by C. S. S. Farney, J. H. Badger, V. M. Porter, W. S. Morse and W. T. Collins.

SAN FRANCISCO, CAL.—Hawkins Electric Company, capital stock $20,000, shares $100 each, subscribed $300, by C. W. Kilpsch, D. L. Anthony and O. T. Barber, 1 share each.

SEATTLE, WASH.—New Westminster-Mission Light & Power Company has been incorporated with a capital stock of $50,000 for the supply of light to the town of Mission City, thirty miles up the Fraser river.

EL CENTRO, CAL.—Evergreen Mutual Water Company, with capital of $10,000. The company will supply water for the Stormer tract at Brawley. Incorporators are: D. A. Stormer, A. J. Albert, Godwin A. Mellen.

RED BLUFF, CAL.—The Deer Creek Power Company has filed articles of incorporation. The power site is in Tehama County, although the principal place of business is in Chico. The capital stock is $100,000, divided into 1000 shares of $100 each, $7000 being subscribed, by C. C. Royce, W. J. O'Connor, A. G. Eames, T. H. Barnard, B. Cusick, Thos. N. Crew and Park Henshaw, $1000 each.

WHITE SALMON, WASH.—The Columbia River & Mount Adams Railroad Company has been incorporated with capital stock of $2,000,000 to build an electric railway from some point on the Columbia River in Klickitat County northerly through parts of Klickitat, Yakima and Skamania counties to a point in the vicinity of Mount Adams.

HOQUIAM, WASH.—Articles of incorporation for an extensive interurban trolley system has been filed with the Secretary of State. The capital stock is $500,000; officers: R. F. Lytle, A. L. Pain and E. O. McGlaufin of Hoquiam, W. H. Abel and Eldridge Wheeler of Montesano, A. H. Abel and P. S. Locke of Aberdeen. The franchise has recently been granted to Mr. Wheeler by the County Commissioners.

SAN JOSE, CAL.—The San Jose Railroads is the name of a new corporation that filed its articles recently. It proposes to take over the First Street railroad line and operate it in connection with the Santa Clara lines. The men interested are: L. E. Hanchett, president; W. R. Lawson, manager, and E. M. Rea, secretary and attorney of the Santa Clara Street line, and F. E. Fitzpatrick, who is associated with John Martin of San Francisco. The capital stock is $5,000,000.

TRANSMISSION.

LODI, CAL.—The Lodi Grape Juice Association will change from steam to electrical power for the coming season.

DIXON, CAL.—The Dixon Gyrating Mill Company at Dixon, California, will increase the size of its present plant and install an additional motor.

WALLACE, IDAHO.—Electric power will probably be installed at the property of the United Lead Mining Company at Osburn this winter to operate the machinery.

VANCOUVER, B. C.—The Vancouver Island Power Company, Ltd., has applied for permission to build a dam and storage reservoir on Bear Creek and Alligator Creek, tributaries to the Jordan river.

EVERETT, WASH.—The County Commissioners have granted the Granite Falls Electric Company a franchise for electric wires and water mains over all the county for a distance of a half mile from the town limits of Granite Falls.

SALT LAKE, UTAH.—A new power plant for furnishing light and power for the Utah Agricultural College at Logan has been authorized by the Board of Trustees of the college. An appropriation of $20,000 was made by the last legislature for this purpose.

VANCOUVER, B. C.—Charles E. Rogers has filed on 200 cubic feet per second of water in Lewis River and Harvey McMunn has filed for 250 cubic feet from the east fork of the same stream, the water to be used in each case for irrigation and electric power.

ROSWELL, N. M.—Mr. Jos. M. Swaziek of El Paso has been here for several days looking into conditions as he expects to locate in the valley in the near future. Mr. Swaziek stated that he will put in an electric power and pumping plant on Penasco river. The power right has already been secured.

LOS ANGELES, CAL.—Trust deeds involving $30,000,000 in bonds and executed in favor of the Harris Trust and Savings Bank of Chicago and Los Angeles Trust & Savings Company of this city were filed in the counties of Southern California by the Southern California Edison Electric Company. In this action the company legally establishes financial organization of new company. Part of this money will be spent in construction of two great power plants on Kern river.

TRANSPORTATION.

LOS ANGELES, CAL.—The Los Angeles Railway Company bought a franchise for Alpine street from Main to Buena Vista, and from Main to San Fernando, of the Council for $100.

LOS ANGELES, CAL.—A car line to connect Dolgeville and Alhambra with Covina by electric line is said to be planned by the Pacific Electric. Engineers have finished the survey.

MOUNT VERNON, WASH.—It is announced that Stone & Webster will build the proposed interurban from this place to Mt. Vernon and Sedro Woolley and it is reported that Richard T. Lafflin, representing the Stone & Webster, announces that work will begin in the near future.

CHIHUAHUA, MEX.—Plans and specifications in detail showing route and approximate cost of projected electric railway which will connect Guadalajara with the town of Chapala on Lake Chapala, have been prepared by engineers of Chapala Hydroelectric & Irrigation Company.

SAN ANTONIO, TEX.—The survey for the interurban line from San Antonio to Fort Worth has been completed here. C. L. Hodges of Chicago, chief promoter, declares laying of tracks will begin within two months. The proposed route is through New Braunfels, San Marcos, Austin and Hillsboro.

SANTA CLARA, CAL.—The Commercial League of Santa Clara is working to secure a right of way through the lands northwest of the city for the extension of the street car system north to meet the line which is to run south from Palo Alto, and which is ultimately to form a through electric line from San Francisco to San Jose.

LOS ANGELES, CAL.—The city will protest against the application of the Pacific Electric Company which desires to obtain permission to build a bridge over the Los Ceritos slough, a part of the San Pedro harbor. The bridge is desired as part of the line to be built by the Pacific Electric from Long Beach to San Diego via Wilmington.

SAN FRANCISCO, CAL.—A. H. Lohman, San Francisco, is making preliminary surveys for the proposed electric line across the mountain to La Honda and the Big Basin. As proposed, the road will start at Red Wood and go to Woodside, from where two routes are under consideration. The approximate cost of the proposed line is estimated at $1,000,000.

WHITE SALMON, WASH.—Adolph F. Suksdorf and others of Spokane have formed the Columbia River & Mount Adams Railway Company to build an electric railway from some point on the Columbia River in Klickitat County, thence through parts of the same county, Yakima and Skamania counties to a point in the vicinity of Mount Adams. The incorporation is for $2,000,000.

OAKLAND, CAL.—Application was made at a meeting of the Council committees last night by the Peninsular Railroad Company for a street railway franchise for a road starting at Fourteenth and Franklin streets, thence down Franklin street to Twenty-first, down Twenty-first to the Sixteenth street depot, forming a loop at the Sixteenth street depot to Eighteenth street, back on Eighteenth street to Brush street, up Brush to Twenty-first and thence back to Fourteenth and Franklin streets.

STOCKTON, CAL.—Construction work is being rushed on the Central California Traction Company's extension of the line designed to connect Sacramento and Lodi, and the company expects to have the interurban road ready for operation by the middle of next summer. One million dollars, it is reported, is the estimated cost of constructing the extension and equipping the road for business. Almost all the grading to the Sacramento County line in San Joaquin County has been finished and graders are now working in Sacramento County. S. B. McLenegan, general manager, is in charge.

ILLUMINATION.

VAN HORN, TEX.—John E. Cox, owner of the Van Horn water works, will put in an electric light plant soon to supply the whole town with light.

LOS ANGELES, CAL.—The Covina Valley Gas Company announces that it proposes to extend mains eastward to Lordsburg, on the city limits of Pomona.

LOS ANGELES, CAL.—For the installation of 200 electric lamps for East Hollywood lighting district the only bid was by the Pacific Light & Power Company.

SANTA ROSA, CAL.—The Board of Supervisors at their last meeting granted the franchise petitioned for by the Cloverdale Light &Power Company to that corporation.

PHOENIX, ARIZ.—The City Council has instructed the city attorney to take steps toward obtaining permission from Congress for the city to bond itself for $300,000 for constructing a municipal lighting plant.

SUISUN, CAL.—The Rochester Oil Company recently resumed sinking for oil in the property near Suisun, California. This company is now furnishing natural gas which they encountered while boring for oil previously.

MERCED, CAL.—The Merced Falls Gas & Electric Company is preparing for a new sub-station to be erected on the lot which adjoins the plant on Fifteenth street in this city. The new station will be about 30x50 feet and will be built of concrete with a steel frame.

ALAMEDA, CAL.—The $300,000 electric light plant of the city of Alameda was endangered by fire December 26 when a vacant building at the south end of Park street immediately adjoining the plant, was gutted by fire. The old frame structure burned fiercely before the fire was conquered.

REDWOOD CITY, CAL.—Attorney Archer Kincaid, on behalf of Benjamin Cunha, has presented a petition asking that steps be taken to sell a franchise for installing and maintaining electric lights in Miramar, Halfmoon Bay and Pursima school districts. On motion of Blackburn action was postponed until the next meeting.

OAKLAND, CAL.—Negotiations by the National Electrical Lamp Company for the purchase of a block of land in West Oakland lying between Peralta and Campbell and Sixteenth and Seventeenth streets, have been completed. It is the purpose of the company which has already established plants in most of the principal cities of the United States, to erect a fine factory on the new site.

WATERWORKS.

SALEM, ORE.—Resolutions proposed by Mayor Rodgers were adopted by the City Council. Salem shall own and operate a water supply system to bring water from Bretonbush.

LOS ANGELES, CAL.—A Goerz & Co., of London, have purchased control of La Fey Anexas mines in Zacatecas district and a bid for a pumping plant will be installed to handle water on property.

OAKLAND, CAL.—As a result of the meeting last week between members of the Park Commission, the secretary was authorized to advertise for bids for the resurfacing of the playground in Bushrod Park and for the laying of pipes in Lakeside Park.

SALEM, ORE.—At the last meeting of the Council the mountain water matter was referred to a special committee empowered to take all the preliminary steps for submission to the voters of the question of building a system to bring the city a pure water supply from Bretonbush and for acquiring the plant of the Salem Water Company and building reservoirs.

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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FOR INDEX TO ADVERTISEMENTS SEE PAGE EIGHT

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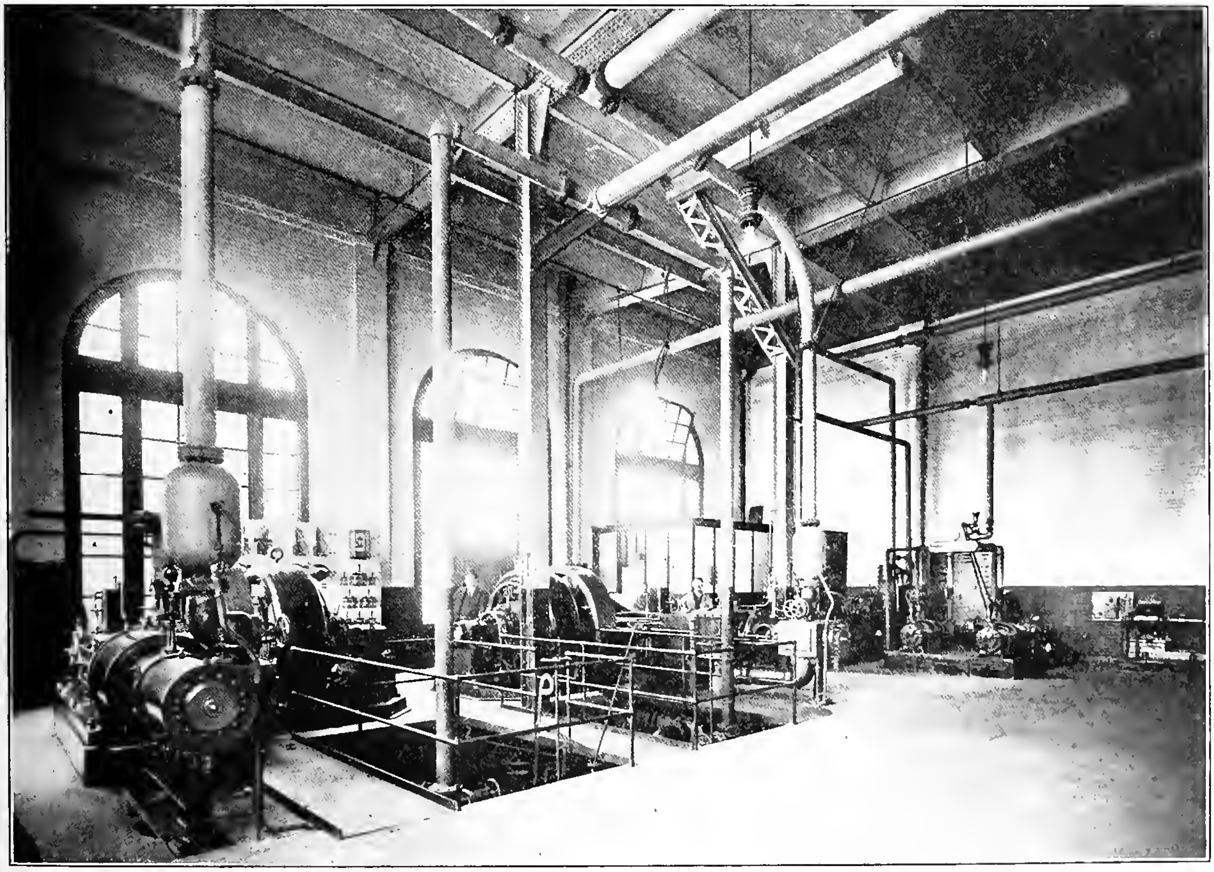
VOLUME XXIV | SAN FRANCISCO, JANUARY 8, 1910 | NUMBER 2

ELECTRICITY IN A MODERN STEAM LAUNDRY

There are but few labors to which electric power can be better applied than those of the laundry. As an example attention is here to be directed to the equipment of the Metropolitan Laundry at Eighth and Harrison streets, San Francisco, which is said to be the largest and most up-to-date in the United States. This installation consists essentially of two parts, the power plant and the laundry proper. Taken together they occupy nearly an acre of ground, and are substantially housed in two brick buildings separated by an alley, under which a tunnel carries the electric conduits, and steam and water pipes, both hot and cold water.

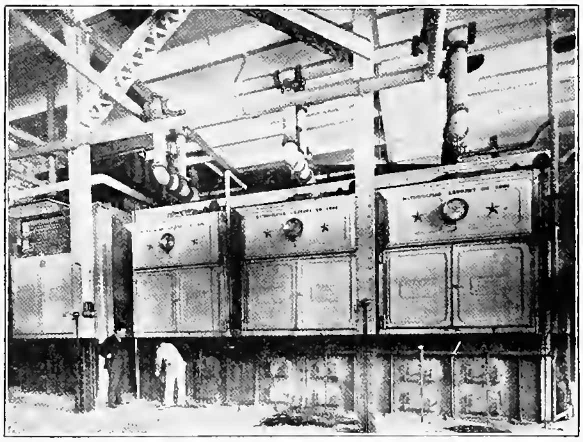
The most noteworthy feature of the plant is its independence from all outside sources of power and water. There is nothing more essential to a laundry than water. This is obtained in abundance from five wells which have been sunk to a depth of 200 feet. Three of these wells are equipped with air-lift and two, with steam pumps, one of the latter being a double acting pump, especially designed and patented by the chief engineer of the plant, Mr. J. G. Dorward.



Power Plant of Metropolitan Laundry, San Francisco.

These pumps deliver the water to a sump from which a motor-driven centrifugal pump elevates it 65 ft. to the top of the water softener.

This is of the Kennicott type with an hourly capacity of 30,000 gallons. The water from the wells is hard, that is it contains about 25 grains of carbonate of magnesia to the gallon. This is precipitated by adding a solution of soda ash and lime as the water enters the top of the softener. This solution is steam-siphoned from a lower mixing vat to a receiver from which it is automatically supplied in any desired proportion to the entering hard water. An ingenious electric contact and solenoid-operated counter in the chief engineer's office gives convenient record of its operation.



Boilers of Metropolitan Laundry.

This Kennicott softener is the largest on the Pacific Coast, holding 125,000 gallons of water, being 18 ft. in diameter and 65 ft. high. By its means 90 per cent of the hardness of the water is removed, which makes a great saving in the wear and tear on the clothes, and also in the soap bill. The softener also supplies water to the boilers, although the chief reason for their remarkable freedom from scale is attributed to the fact that the plant is run condensing. The cooling water from the condensers flows to a tank which supplies the laundry, its heat being further maintained by the exhaust from the air compressor.

The hardening ingredients in water destroy the effect of large quantities of soap by uniting with it and forming an insoluble compound known as "soap curd." Each degree of hardness per gallon of water destroys approximately 1½ pounds of soap per 1000 gallons of water before any detergent action is produced. In other words, the hard water is softened by the use of soap before any beneficial action is obtained from the soap. To overcome this wasteful result laundry men are forced to add sodas to the water, which precipitate the hardening ingredients upon the goods, making them very harsh. These sodas also rapidly destroy the fibre. The soap curds, deposited in the fibre of the goods, being insoluble cannot be removed by subsequent rinsing. These curds cause white goods to become a dirty gray and are decomposed by the hot iron, causing greasy appearing, yellow stains or streaks most frequently noticed at the seams. The harshness, due to these curds and the hardening ingredients precipitated by the washing sodas, is especially noticed in woolen and flannel goods.

The steam plant supplies power for pumping 175,000 gallons daily, and also furnishes electric current for heating, light and power in the laundry. The boiler equipment consists of three Heine safety water-tube boilers made by the Risdon Iron and Locomotive Works, of San Francisco, each of 277 rated horse-power. There is also a low pressure Risdon boiler used as a water heater. The boilers are oil fired and equipped with McLain oil burners, the duplex oil set being a 4½ x 2¾ x 4-in. Worthington.

The generating plant includes four Westinghouse direct current dynamos arranged for three-wire service. The two main generators are 150 k. w. 220 volt machines direct connected to tandem compound Ball engines, 11 x 19 x 20. The hot-well, feed-water pumps and condensers are placed in a pit between the two engines. All condensation from the laundry is returned to the power plant and by this means fully 75 per cent of the water is saved. In addition, there are two 17½ k. w. d. c. Westinghouse generators driven by Ohmen engines, which are used to even up the unbalanced load on the large generators and to supply current for lighting and operating the different departments when necessary to run overtime.

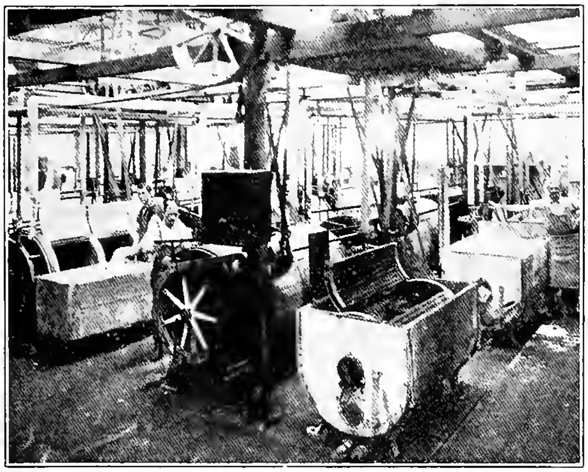
By means of the three wire system, current for lighting is supplied at 110 volts and for power at 220 volts. The Westinghouse three-wire system, as here installed, is so arranged that the current is supplied by one machine, so in the event of light load it is not necessary to run the two generators. The generators differ from the standard single voltage, direct-current machines by the addition of auto transformers and an arrangement of the armature lead connections somewhat like those on the alternating current side of the armatures of rotary converters, the armature lead of three-wire dynamos being connected to collector rings placed on the shaft. The connections from the armature to the collector rings are two-phase, across which a pair of auto-transformers or balancing coils are connected. These balancing coils consist of a single winding upon a laminated iron core. The assembled coils are placed in iron cases filled with oil. The middle points of the balancing coils are inter-connected and from this connection the neutral lead of the three-wire system is led. It is obvious that the pressure between the neutral wire and either generator terminal is one-half of the 220-volt generator pressure. In this installation the coils have been placed in the wall, close to the switchboard, which arrangement has proved eminently satisfactory.

The switchboard consists of four panels,, one for the two 150 k. w. generators; one for the two 17½ k. w. machines; one for the motors in the power plant, and one for the power and lighting circuit in the laundry.

As already mentioned, a 30-in. centrifugal pump, single stage, built by the Risdon Iron Works, is driven by a 20 h. p. motor to pump water from the sump to the top of the softener. There is also a steam driven air compressor installed by the Compressed Air Machinery Company, of San Francisco, supplying air for

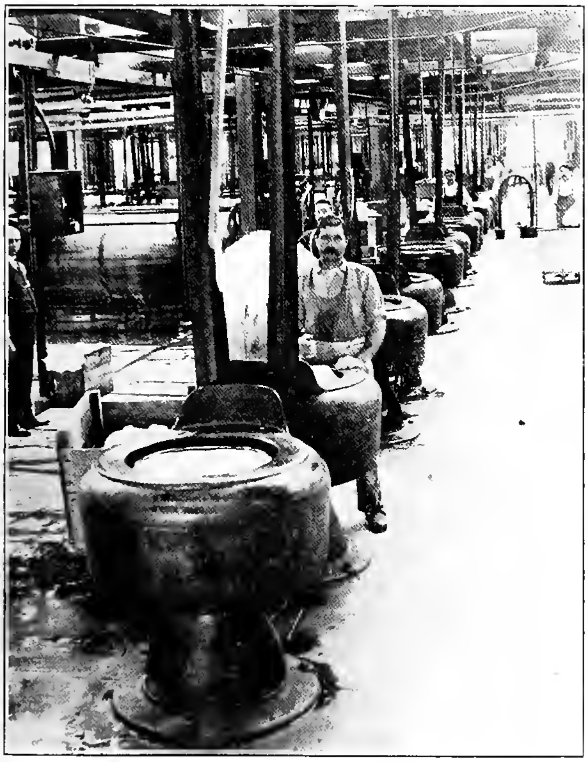
the air-lift pumps and to various machines in the laundry.

The lighting circuit supplies current not only for the incandescent and arc lamps with which the plant



Motor-Driven Washing Machines.

is equipped, but also for the electric irons. These are the standard irons manufactured by the Pacific Electric Heating Company of Ontario, California, and take from 6 to 10 amperes at 110 volts. As there are 50 of these hand irons the large amount of current required is readily appreciated. But considering the



Motor-Driven Extractors.

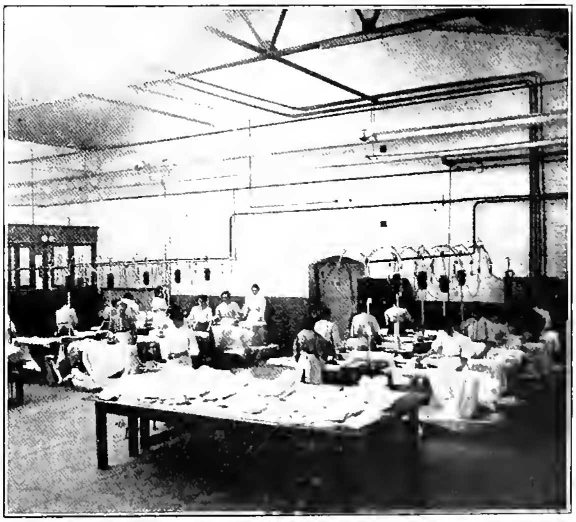
great amount of time that they save and the excellence of the work they do, the cost is well justified.

The power circuits furnish current for electric drive of all the machines in the laundry, including washers, extractors, mangles and ventilating fans. These motors aggregate sixty-two in number and vary in size from 1/4 to 20 h. p. They are all made by the General Electric Company and where not direct connected, are equipped with the Morse silent chain.

Motor-Driven Flat Work Ironers.

Upon delivery from the wagon, all pieces are first marked for identification, either by hand or more recently by a motor driven marking machine, manufactured by the National Marking Machine Company. This machine resembles a linotype without the matrix-casting mechanism. The pieces are then segregated as to kind, for each class, such as blankets, flannels, toweling and starched pieces, requires different treatment. All plain pieces are first placed in washing drying and are dried and smoothed in the flat work irons. Collars, shirts and other starched pieces are washed in machine and dried in steam-heated drying rooms, being ironed by hand.

There are 110 washers arranged in ten clusters of



Electric Hand Irons.

eleven each. Each cluster is driven by a 15 h. p. motor. Hot and cold water is supplied from the power plant and soap is made on the premises.

The extractors, or wringers, are 40 in number, being arranged in ten lines of four each. Each set of four 28-in. extractors are driven by 7½ h. p. motors

from overhead line shafting. These are used for drying the heavy and the coarse pieces.

There are eight Hagen mangles, two being four-roll and the others six-roll machines. Each is operated by a three h. p. variable speed General Electric motor with rheostat control.

There are five conveyor dryer houses, each operated by a ¾ h. p. motor. These are heated by steam coils and during the course of one-half hour's travel through them, the finer pieces are completely dried. There are also three lines of shirt machines, each driven by 5 h. p. motors. All the dryer houses are supplied with steam at 120 lbs. pressure, the power plant being operated under 160 lbs. pressure. The steam line to the laundry is set with a 4-inch safety valve connected to the 6-in. line, so as to protect the laundry machinery, in case high pressure steam is accidentally introduced when the boilers are changed. The flat work irons are all steam heated. This condensation, as before mentioned, is from the steam traps returned to the power plant. In the collar department, the collar tables, ironers and dampeners are all operated by individual motors, connected to the machine by Morse chains. In the shirt department there are 18 body ironers, gas heated, one 3 h. p. motor operating six machines. This plant is under the management of F. F. Connor.

AIR-NITRATES IN GERMANY.

Consul-General A. M. Thackara of Berlin answers as follows the queries of an American correspondent regarding the manufacture of air-nitrates and the status of farming in Germany: Atmospheric nitrogen is utilized in making nitrates for fertilizing purposes, in accordance with two general systems in Germany, as well as in Norway, Italy, and other European countries, and in Canada. (1) The formation of the so-called calcareous nitrogen (kalckstickstoff), which has the chemical formula $Ca(CN)N$, and which is formed by passing nitrogen over heated calcium carbide or through a heated mixture of lime and charcoal, and (2) the direct combination of the elements in the air—oxygen and nitrogen—by the use of the electric spark and the formation of nitrate by bringing these combinations into contact with the proper calcium or other components.

There are several processes by means of which the nitrogen, which combines with the calcium carbide in the formation of calcareous nitrogen, is separated from the oxygen of the air. One is by passing air over the copper coils by means of which the oxygen is removed. Another process is to obtain free nitrogen by the partial evaporation of liquefied air. The great expense attending this latter process renders it impracticable, and the nitrogen so obtained is still much mixed with oxygen compounds. Nitrogen is also obtained by one German firm in Hamburg and Hanover by cooling the gases of combustion and removing the impurities by passing the gases through retorts filled with copper and copper oxides and then through some substance that absorbs the carbon dioxide.

The so-called calcareous nitrogen obtained by the various processes is a grayish substance containing about 20 per cent nitrogen. As a fertilizer it is generally supposed to be as efficient as ammonium sulphate and but little inferior to saltpeter. The exact effect of the cyanide in the compound is as yet not understood. By heating, the whole of the nitrogen in the compound is changed into ammonia, from which ammonium sulphate may be formed. The practicability of the production of calcareous nitrogen depends upon cheap power supply, and hence the plants are generally located where water power is available. The substance is produced in many different countries and the estimated total production for 1908 was about 45,000 tons.

The second system by which nitrates are obtained by the direct combination of the oxygen and nitrogen of the air is much more recent in its development than the above. After numerous attempts had been made in various countries, the Norwegian inventors, Birkeland and Eyde, finally succeeded in making the process industrially practicable. According to their system, the end of each of the electric poles through which a current is passing is exposed to the action of a magnet which causes the electric spark to spread out into a disk-like flame. This flame is surrounded by some material that resists combustion, thus leaving a disk-shaped inclosure through which the air is drawn. As the temperature at which this reaction takes place is very high and as the atmosphere passes comparatively rapidly through the flame, only from 1 to 2 per cent of the elements in the air is transformed. The compounds formed begin to decompose when their temperature is lowered, and therefore methods are devised to rapidly decrease their temperature to the point at which they can form more stable products. For this purpose the compounds are passed through an evaporating apparatus, and after their temperature has been reduced to about 50 degrees Reaumur they are passed into an oxidation chamber and oxidized into nitrogen dioxide, from which the nitrates are made. The greatest advance in this system has been made in Norway, principally by the firm of Birkeland & Eyde, and in factories located at Notodden, Svalgfos and Christiansand. A similar system in Germany is used at the "Badische Anilin und Soda Fabrik" at Ludwigshafen am Rhein. The nitrates so formed are quite pure and have thus far been consumed principally in the industries, only a small quantity having been used as fertilizers.

The cost and the volume of production of each system depend upon the availability of cheap power, and the production of calcareous nitrogen also depends upon the prices at which lime and coal or charcoal are available. One estimate places the cost of the production of calcareous nitrogen containing 20 per cent nitrogen at 270 to 315 francs ($52.11 to $60.79) per metric ton (2,204.6 pounds). This would make the nitrogen in the compound cost 26 to 30 cents a kilo (2.2 pounds), while the cost of the nitrogen in compounds formed by the direct combination of the elements in the air is generally conceded to be less. The experiments made with fertilizers of either system, in comparison with Chilean saltpeter, are generally favorable to the artificial product. In sandy soil the calcium nitrate formed by the direct combination of the elements in the air brought even better results than the Chilean saltpeter.

GOING VALUE AS AN ELEMENT IN THE APPRAISAL OF PUBLIC UTILITY PROPERTIES.[1]

BY WM. H. BRYAN.

Appraisals of public utility plants are made for a variety of purposes—sale, bond issues, taxation—and more often in recent years as a basis for rate-making, a function which is coming more and more to be exercised by the State or municipal authorities.

Such appraisals must cover both the tangible and the intangible values. The former present no great difficulty, being usually taken as the present cost of duplicating the property used and useful for the convenience of the public, less depreciation. The intangible values are usually two in number, "franchise" and "going" value.

Where the utility is operating under an existing franchise, future net earnings during the unexpired period are estimated. These, when reduced to present worth, fairly represent franchise value. Where the franchise has expired, or where the municipality has the right to purchase at stipulated periods, there is, of course, no franchise value.

Going value, however, may continue even after the franchise has expired so long as the plant continues to serve the community. This value was first officially recognized in Judge Brewer's decision of the Kansas City Water Works case (see United States Federal Reports, 62—853) in the following language: "The city steps into possession of a property which not only has the ability to earn, but is, in fact, earning. It should pay, therefore, not merely the value of a system which might be made to earn, but that of a system which does earn."

It is an unfortunate fact, however, that agreement is still far from general among engineers both as to the exact definition of going value and the proper method of determining its value. This is well illustrated in a recent compilation of twenty valuations, in which it varies all the way from 0 to 47 per cent of the physical value of the plant. Even wider ranges would probably be found if all the appraisals in which it has been considered by able engineers of varying view-points could be compiled and compared. In one of the most important appraisals of recent years, in the hands of five of the leading specialists of the country, no two of them agreed as to the method of computation.

There is, however, much evidence indicating that substantial progress is being made towards clearer and fairer views. The author ventures to indulge the hope that it may soon be possible to so handle this matter that the justice and fairness of our methods will be so apparent as to appeal, not only to specialists, but to judges and juries and to mayors and boards of aldermen as well. There must surely be a way to so determine going value as to satisfy both seller and purchaser.

Perhaps the clearest official utterances thus far made on this subject are the recent decisions of the State Railway Commission of Wisconsin. In the Cashton Light & Power Company case they said:

"The element of "going value" created by the investments made in developing the business and in addition to the cost of the physical structure must be taken into consideration in fixing value; although the franchise of a public utility operating under an indeterminate permit has expired upon the exercise by the municipality of its option to purchase, the plant is to be taken over as a going concern, and just compensation must be awarded for the property taken as a living and operating entity, engaged in serving the public, and not as a mere plant without patrons and without privilege or right to operate and to serve the public and having but a salvage value."

Also in the Antigo water and the Marinette telephone cases:

"The theory of the Wisconsin public utilities law is that rates shall be reasonable and shall be not greater than enough to yield a fair return on the investment. In determining the investment as a preliminary process to the fixing of rates, the Commission had to deal with the claims of large "intangible" franchise values as well as "going values," in both the Antigo water case and the Marinette telephone case. Regarding the former, the Commission holds that if the municipality required the payment of money or its equivalent, or there was necessary legitimate payment made for the franchise, then the sum which may reasonably be said to have been paid for the franchise may be included in the valuation, the same as money necessarily invested in the physical property. But the Commission refuses to consider the claims of some experts and corporations that franchises for which no money was paid may have "intangible" values which should be considered in the making of rates.

It has been held by experts that "going value" should be allowed as so much per customer, or as a percentage of the receipts, and some have considered it as of as great, if not greater, importance than the physical value of the plant. The Commission holds that the actual reasonably wise expenditure of money towards getting the business of the plant established may be included in the value to be allowed for the purpose of fixing rates. Since no plant pays at the outset, and the first years of operation are almost invariably accompanied by losses or necessary deficits, the Commission holds that such losses may be said to represent the cost of securing an established or going business, and as such may be included in the value or investment upon which the rates for public service shall be fixed. But the converse of the rule also holds; that is, if a plant has in the past earned more than a reasonable return, possibly through the toleration of excessive rates, the excess over reasonable earnings may, under certain conditions, be subtracted in determining the present value of the plant. That is, a "going value" may be negative. In the case of the Marinette Telephone Co., for example, the Commission found upon its investigation of the financial history of the company, that through a period of recent years the company had been enjoying a sufficiently high rate of return to write off the early deficits in so far as such deficits might be allowed as going value.

It may be noted in passing that the now generally accepted view is that the plant value upon which a

[1]Read before the Engineers' Club of St. Louis, October 20, 1909, and printed in the October, 1909, "Journal of the Association of Engineering Societies."

fair return must be earned is the present cost of duplicating the existing plant (less depreciation) and not its actual original cost. It is not material, therefore, what the original outlay for franchise may have been, but it is important to know what moneys, if any, would now have to be expended to secure such a franchise. Neither are past losses or profits conclusive further than as they throw light upon probable future earnings.

The important facts in the above rulings are that the Wisconsin Commission has officially recognized the propriety of including going value in appraisals and has pointed out that it should be computed as the sum of two outlays:

First, moneys spent directly for getting business; and

Second, moneys advanced to cover losses in the earlier years of operation.

These amounts, of course, are not the sums which the plant under consideration may actually have expended, but the amounts a plant starting today would probably have to pay to secure sufficient business to make the plant self-supporting.

Having ascertained the present value of the physical plant, the Commission considers it proper to add to it these two amounts, the total being the fair value at which the plant might be sold, or upon which the owners are entitled to earn a fair return.

Assuming the existence of the bare physical plant, without connections or business, what additional outlay would be necessary, under the conditions existing at the time of the appraisal, to bring its income up to a point where its losses would cease and it would begin to earn a fair return?

Legitimate expenditures to build up business would cover such items as advertising circulars, solicitors, special rates or even free service for limited periods, free connections, plumbing at or below cost, etc. Not infrequently solicitors are paid a fixed sum per contract brought in. Such outlays would unquestionably hasten the attachment of services and thus shorten the unproductive period. For a water works it would be proper to take into consideration the present-day general knowledge and appreciation of the advantages of water under pressure, and the fact that it is now a necessity in manufacturing, commercial and domestic life. In any modern city the demand would be immediate and extensive, and the rapidity of securing business would in most cases be limited only by the ability of the working forces to install the plumbing and make the connections. At starting, the plant would have tht public revenue from fire hydrants, public buildings, fountains, etc., and soon thereafter the income from a considerable number of private consumers. This would cover a large part of the operating expense, probably half or more It then remains for the appraiser to estimate the period within which the necessary volume of business would be connected and to compute the probable losses up to that time. This is a matter calling for the trained judgment of a skilled observer. It depends upon the size of the city, the character and habits of the people, their wealth, the number of factories, breweries, railroads, etc., and the quality and quantity of other available supplies, such as wells and cisterns, and many other things.

The physical value of the existing plant is ascertained by estimating the cost of a duplicate plant and deducting depreciation, such cost including, of course, interest, administration, etc., during the construction period. Some engineers hold that as this duplicate plant could not be gotten into actual service for a considerable period, the net earnings of the existing plant during that period are properly a part of going value. The income of the existing plant being limited, however, to a "fair return," there would be no excess earnings, and, therefore, nothing to add. From this standpoint the city's right to purchase in no way affects going value.

The probable operating expense of the "starting plant" may be projected into the future with reasonable accuracy. It must, of course, include not only the ordinary expenditures for labor, fuel, supplies, etc., but also taxes, repairs, administration, interest and depreciation. The growth of income, however, is not so easily estimated, as it involves both the volume of business and the rates charged.

Income depends upon rates. A favorable schedule, not necessarily the highest, will shorten the unproductive period and thus decrease going value. Unwise rates retard growth and increase going value. Attempts to determine going value must, therefore, pre-suppose some basis of rates. But rate revision, directly or indirectly, is the purpose of most appraisals. To assume rates as a step towards fixing rates is to reason in a circle. What, then, shall be done?

Many appraisers assume that existing rates continue. It is argued that they furnish the only definite data available affecting income. To change them would be to enter upon the problematical. But existing rates may be either too high or too low for a fair return.

The tentative or "cut and try" method would seem much preferable. First compute income and then going value, using existing rates. If that income is more than a fair return, repeat the calculation at a lower rate. If insufficient, try a higher schedule. Continue these trials until a rate is found which will insure a fair return within a reasonable period. The going value on this schedule would seem to be the proper one.

Going value thus determined is clearly independent of whether the franchise has expired or whether the city has the right to purchase. It enters into the appraised value of the plant, just the same as any physical item, at its cost of reproduction.

It is interesting at this point to note the Wisconsin Commission's conclusion that going value may be negative, when later profits above a fair return have more than wiped out the deficits of the earlier years. Is not this a reasonable consideration for the future? Assuming a rate schedule and growth of business which would make the plant self-sustaining within a reasonable period, the normal continuation of that growth would cause the plant to earn profits which would soon offset the earlier losses and thus destroy our measure of going value. It would be within the legitimate power of the authorities to so adjust rates as to bring this about.

The author of the paper above referred to defines

the going value of an existing plant as the cost of reproducing the income of that plant. He fixes its amount by computing the difference between the net results of its operation and the net results of a well-conducted "starting plant, through the time necessary to enable the starting plant to be completed and recover an income equal to that of the going plant."

The differences between these views and those now officially promulgated by the Wisconsin Commission, which, by the way, are held by many able engineers, are worthy of serious consideration.

The first difference is one of definition, Mr. Alvord holding that the income, the cost of producing which is to be estimated, is the gross income of the existing plant. The Commission's views is that an income sufficient to meet operating expenses is sufficient. Lossess having ceased, further business is secured without cost. Previous losses may properly be called going value and charged to capital account. A greater income is of no interest or value to the municipality, for rates will at once be readjusted to the "fair return" basis, whether the appraisal is for sale or for rate fixing. No city could fairly be asked to pay an inflated "going value" based on an excessive income which it will immediately proceed to reduce. Existing income based on existing rates is, therefore, valueless for this purpose, and may even be misleading, as producing sometimes more, sometimes less, than a fair return.

Viewed from this standpoint, the financial history of the existing plant has only an indirect interest. It may help us to estimate the cost of operation and to form some judgment as to the time within which the starting plant will begin to earn a fair return.

The second difference between Mr. Alvord and the Commission lies in the method of computation. Nowhere does he recognize the direct expenditures for getting business already referred to. He compares the existing plant already doing business as a going concern with a similar "conceptual" plant without business, which would have to be built and put into operation. Meanwhile the business of the existing plant continues its normal growth. He concedes, however, that at some future date the starting plant will acquire an income equal to that to which the existing plant has then grown. The difference in net operating results up to this date comprise, in his opinion, the full measure of going value.

Two perplexities here confront us. The existing plant, with its prestige of years, its standing in the community, its "going value," if you please, would seem to have a permanent advantage. Having usually twenty or more years the start, ought not its continuing growth to keep it permanently ahead of the newer plant? And if there is to be forever a difference in their income, then the going value thus computed must be infinite.

If, however, the "starting plant" is assumed to grow at so rapid a rate that in a few years its income equals that of the existing plant, why should that rate of growth then suddenly drop to that of the existing plant? Will not the same conditions which have caused its previous rapid growth continue? If they do, thenceforward there would be an excess of income which would soon wipe out the earlier shortages, as has been well pointed out by the Wisconsin Commission.

A system of computing value whose results may range all the way from zero to infinity is not pleasant to contemplate. But these difficulties vanish when the "fair return" income, and not the existing income, is taken as the basis.

The above method might fairly measure the increased worth of the existing system to a private purchaser as compared with a prospective plant without business, assuming a continuance of rates and income. But such assumption cannot be made in the case of municipalities (except where unexpired franchises exist), as the ultimate purpose of practically all investigations of this kind is rate revision. Furthermore, the cost of reproduction is the ruling condition, not the value of the thing reproduced, exactly as is the case with a pumping engine or any other feature of the physical plant.

Many attempts have been made to compute going value along similar lines, although but few have followed the exact definitions given. In some such comparisons interest and depreciation during the construction period have been assumed equal on the existing and starting plants, while they should not be charged against the starting plant at all. There is no depreciation prior to the start, and interest is always included in the construction account.

This, however, brings up another matter. As has been well said, it is not fair to substitute hindsight for foresight. No designer can foresee all possible contingencies; no engineer is infallible. Mistakes have always been made, and always will be. Boilers, engines, standpipes, buildings, reservoirs, purification systems, even sources of supply, have failed, necessitating removal and, in some cases, abandonment of entire plants. Sometimes the city has not grown in the direction originally expected. Even the most capable and experienced designers, associated with men of the soundest business judgment, have encountered such disasters. It is a hazard of the business. If a new plant were begun tomorrow either by private parties or the municipality, this risk, in greater or lesser degree, would necessarily inhere in it.

No fair-minded appraiser, however, would include allowance for such mistakes, however unavoidable. The city cannot fairly be asked to purchase at or pay rates on values so determined. But does not the fact that the existing plant has, as it were, "sown its wild oats," has discarded its unwise and useless equipment and has demonstrated the fitness of its remaining parts, make it of more value than a new plant with that unavoidable experience still to go through?

The author confesses to some uncertainty as to just where this factor should appear, but that it is an element which should not be overlooked he is certain. For lack of a better place he suggests that it have its weight as one of the "contingencies" in fixing the percentage to be added to the cost of reproduction. In the average case, however, its value would not be large.

What should be the attitude of the conscientious appraiser towards those plants which are losing money? Has such a plant a going value? This question has been answered in all seriousness in the

affirmative. It has been held that an established plant would lose less money than one with its business still being developed. Under Mr. Alvord's method the excess in loss of the "starting" over the existing plant would measure the going value. The Wisconsin Commission plan could not, of course, be applied, as the continuing losses would make the going value unlimited. Under these circumstances there may be several views:

1. A study of the situation may show that the normal growth of the business will soon end the losses.

2. The losses may be decreased, and in due time ended, by some reasonable advance in rates. In both of these cases the Wisconsin rule could safely be applied.

3. If, however, the situation is such that there appears to be no reasonable way to make the plant earn a fair return, the solution becomes complex.

Such cases, unfortunately, are not uncommon, particularly in smaller cities and in undeveloped or boom territory. Sometimes both the city and the owners have been over-sanguine as to the future. Many cities have in times of enthusiasm and prosperity been induced by energetic promoters to enter into contracts for service which have later proved exceedingly unwise for all parties concerned. Business has not developed, nor has the place grown as anticipated. Important industries may have ceased; opposition towns or railroads may have taken the business away.

While the plant is losing money at the existing rates, it is nearly always true that these rates, both public and private, are a serious strain on the limited resources of the city and its people. No advance is, therefore, possible; it may even be impossible to maintain existing rates. Not infrequently the expiration of the contract is looked forward to as a date when relief may be expected.

Such contracts are usually for periods of twenty to thirty years. Usually all obligations between the parties end with the expiration of the contract. There seems no escape from the conclusion that the owners of the plant must accept the situation as it then exists. As they would have been entitled to the profits of a successful plant, so also must they accept the losses of the unprofitable one. If the cost of service is beyond its means, the city is at liberty to discontinue it. If the contract made no provision for extensions, or if such provisions were illegal, the plant has no rights superior to those of the municipality. It is to be presumed that the owners knowingly took the risk of securing, within the contract period, such returns as were necessary.

This view is, of course, hard on the invested capital, but the law very wisely prohibits municipalities from incurring obligations which may prove onerous to future generations. Posterity should not be made to suffer through the errors of earlier days. In some cases it has been held that, owing to the uncertainties attending the situation at the end of the contract, the "fair return" basis entitled the owners to rates which would make the earnings sufficient to retire the entire investment, less scrap value, within the contract period. This interpretation, however, is very rare. It has a counterpart in those states which require the establishment of sinking funds by municipally owned plants to retire the bond issue within a definite period, usually much less than the life of the plant.

The problem then is, not whether a going value should be included in the value of the plant, but to determine a value which the maximum income possible under the existing circumstances will support. In other words, the actual worth of the service to the community fixes a limit to the value of the plant, beyond which no figures, however elaborate or logical, can go.

Under a strict interpretation of either the Alvord or the Wisconsin theory, the city would be required to purchase the plant at a valuation, or pay rates giving a fair return on a valuation based on cost of duplication less depreciation plus going value. The latter, on account of the slow building up of the business, would be large.

Clearly, however, this would be unfair to the city, as involving prohibitory rates, rates which the public service could not stand, and which would discourage private consumption and prohibit growth, thus minimizing private revenue. The difference could not be made up by increased taxation, as this is limited by law.

We may of course, take the broad stand that if a city wants water works it must pay the price; they cannot be run as charitable institutions. But there is a limit to the city's ability to pay. Is it not true, therefore, that the plant, in order to continue to serve the community, must be willing to adjust its rates to a basis which the people can pay? Would not any other course necessarily end in forcing the city to discontinue a service beyond its means, a result disastrous to all concerned?

Evidently the construction of a plant at all in such a location was a mistake on both sides. Is it not the clear duty of the appraiser in such cases to eliminate, on the one hand, every possible element of questionable value and to get his figures down to bed rock. in the hope of finding a way to meet the exigencies of the situation, and, on the other hand, to see that the city acts in equal good faith, that it properly appreciates the full value of a good supply and apportions the maximum amount possible to that service? It is worth remembering that in many cases the lowering of private rates to points originally considered suicidal has so attracted consumers as to materially increase both gross and net income.

Evidently in such unfortunate cases the situation demands a valuation quite apart from the actual physical plus the going values, however just those values may in the abstract. Fairness to the municipality is not less essential than fairness to the plant. The courts have decided that while such regulations are intended to be mutually fair, they must in any event be fair to the city.

Clearly such reasoning is only effective when the city is prepared for the alternative of abandoning the service. If it is so situated that it cannot do without the service, then it must find a way to pay a fair return for it. But in no event can the value of such

a service exceed the cost of getting that service in some other way.

Further perplexities are often found. It has been questioned by many fair-minded men whether the plant, after all, has any ownership of the business on which going value is based. Should the people pay for what they have themselves furnished? Certainly such value can go no further than the actual cost of reproducing that business.

It will be noticed that both the Alvord and Wisconsin methods give the greatest going value to those plants which have had the longest and hardest struggles to build up their business, while such plants are actually worth the least as commercial propositions. Prosperous plants, with large business quickly established, have the least going value, though far more attractive to the investor. The same is true as regards rates. A high schedule usually means low going value, while low rates increase going value.

With such wide divergencies of opinion among thoughtful and fair-minded men, it is not strange that much effort has been devoted to the finding of better and simpler methods. Nor is it strange that, despairing of success, shorter methods, less logical, perhaps, but giving due recognition to the underlying principle, should find favor. Some of these may be noted:

In one of the most important cases of recent years, in the hands of men of great ability, the results of various methods of computation were all found to be reasonably close to one year's gross revenue, and that sum was finally agreed upon.

In the recent Staten Island case the going value was arbitrarily fixed at $10 per service.

In Canada a flat addition of 10 per cent is made to the physical value to cover all the intangible values. See Municipal Acts of Ontario, third edition, VII, chapter 19, section 566, sub-section 4, clause (a2), which reads:

"In any arbitration under Clause (a) hereof to determine the price to be paid for the works and property of a gas or water company, the arbitrators shall determine the actual value of such works and property, having regard to what the same would cost if the works should be then constructed or the property then bought, making due allowance for deterioration and wear and tear, and making all other proper allowances, but not allowing anything for prospective profits or franchise, and shall increase the amount so ascertained by 10 per cent thereof, and such increased amount shall be the amount which the arbitrator or arbitrators shall award as the price to be allowed for the said works and property."

In drawing a new water contract at Mexico, Mo., the author recently adopted a somewhat similar idea, as follows:

"Purchase by City.—The city shall have the right to acquire by purchase all the property of the grantee actually used and useful for the convenience of the public at any time after the expiration of fifteen (15) years from the passage and approval of this ordinance by public vote, upon giving one year's notice to the grantee and upon paying therefor in cash the then cost of duplication, less depreciation of said property, with ten per cent (10 per cent) additional thereto as compensation for earning power, franchise value, going, contingencies and all other intangible values of every nature whatsoever."

Mr. Alvord's concluding remarks indicate a preference for using the actual cost of the existing plant, where it can be ascertained, as the basis of fixing rates, rather than the present cost of reproduction less depreciation, because of the exceeding complexity of the computations. It may be questioned whether many appraisers will follow him here. The idea is fundamental that present values and rates must be based on present-day conditions. Nor is it usually difficult for able, experienced and fair-minded appraisers to agree with reasonable closeness on physical values.

When the intangible values are taken up, the situation, as has been shown, is far different. Here, if anywhere, simple and direct methods, appealing more strongly to the average man's ideas of fairness, are needed. And from this standpoint the simple methods used above are not without merit.

PETROLEUM IN 1909—DECREASE IN PRODUCTION.

According to reports received by the United States Geological Survey, the remarkable rate of increase in the production of petroleum that extended through 1907 and 1908 was checked in 1909.

The total production for the United States in 1909, as estimated by David T. Day, of the Geological Survey, was between 173,000,000 and 178,000,000 barrels, as against 179,572,479 barrels in 1908. The decrease was less than had been expected in view of the great accumulation of stocks during the preceding year. This accumulation occurred entirely in States east of the Rocky Mountains that have no trade connection with California, and this State therefore showed a great gain, in which nearly all its pools participated.

California now stands first in oil production, producing fully 10,000,000 barrels more than Oklahoma, which ranks second. Developments begun in 1908 continued with increasing rapidity in 1909, many sections producing wells of large capacity.

One of the important events of the year—an event that created excitement in oil circles—was the drilling in September of the Silver Tip well on Section 6, Coalinga field. This is said to be, with the possible exception of the Hartnell well, of the Union Oil Company, drilled at Santa Maria in 1904, the greatest well ever drilled in the State. Other important developments have extended the Coalinga field to the west and south. Successful wells drilled in the Sunset, Midway, and other districts show the wonderful richness of the oil fields of the State. During 1909 several pipe lines were under construction to carry the increasing product, and although no exact statement can yet be made as to the total production there was undoubtedly a very substantial gain over the output of the previous year and a satisfactory increase in price.

WATER POWER RESOURCES OF THE GREATER NORTHWEST.[1]

BY O. L. WALLER, C. E.

With the Olympic mountains west of the Sound, the Cascades extending from north to south across the State, the Blue Mountains in the southeastern part of the State, and the Bitter Root and Rocky Mountains on the east furnishing lofty watersheds covered with perpetual snows, the power of streams of Washington is destined to add very considerably to its material growth.

The Columbia River, with its many large tributaries from Montana, Idaho and British Columbia, draining an area of 250,000 square miles, and drawing its supply from the snow fields of great mountain ranges, affords large possibilities for power developments. The annual minimum flow above Kettle Falls is reported as ranging from 19,000 to 30,000 cubic feet per second. This is a run-off from a drainage area of 63,160 square miles, of which 10,000 to 12,000 square miles is lake surface. At Kettle Falls the drop is 37.5 feet over a dike of rock, making a dam and power development extremely simple. With some storage the energy of these falls may be safely rated at 100,000 horsepower.

At Rock Island there is a fall of 72.5 feet in 8,000 feet, and a minimum discharge ranging from 23,000 to 34,000 cubic feet per second. The energy now wasted at this point amounts to 190,000 horsepower.

At Cabinet Rapids the fall is 10 feet in 8,000 cubic feet, and the energy equals 26,000 horsepower. At Priest Rapids the fall is 72 feet in 10 miles, and the energy of the stream is 188,000 horsepower.

In the section known as the Grand Dalles, which includes the cascades at Celilo, Ten-Mile Rapids, The Dalles, Three Mile Rapids and Two Mile Rapids, the fall is 80 feet, 20 feet of which is a sheer fall at Celilo. The minimum flow is rated at 26,000 to 37,000 cubic feet a second and the minimum energy of the stream is 236,000 horsepower, of which the fall is 24 feet in 3,000 feet, and the minimum energy of the stream is 71,000 horsepower.

Besides the large falls and cascades referred to, there are many others from Kettle Falls on down to Rock Island. While the Snake river has much swift water, the removal of dangerous rocks would make it navigable from its mouth to some distance above Lewiston, Idaho, and consequently it does not afford many promising power sites.

The power in the Spokane River has already been developed in several places, namely, Post Falls, the city pumping station at the series of rapids and falls at Spokane, and at a point nine miles below Spokane, and at a point opposite Reardan. In all 100,000 horsepower has been developed. Some of this acts directly on the turbines of the city pumping plants or of flour, feed and saw mills. The greater part, however, is converted into electricity at high voltage and transmitted long distances for light and power. In general, nearly all the light and power used in the State, with the exception of that developed by the lumber industries, which burns slabs, edgings and sawdust, is supplied from hydroelectric developments.

Most of the towns and cities in the Inland Empire are supplied with light and power from the Spokane River, while interurban railways supplied with power from the same source are rapidly threading the rich wheat and produce belt of Washington and Idaho.

The fall of the Methow River is about 25 feet per mile, with a minimum discharge of 400 cubic feet a

Priest Rapids Power Plant in Columbia River.

[1]Pacific Builder and Engineer.

second. Along its course from Twisp to its mouth there are many fine power sites where dams could be thrown across the river and economical development be made.

The minimum flow from Lake Chelan is about 812 cubic feet a second, the fall 360 feet and the energy about 33,000 horsepower. The development here will be simple and quite inexpensive. If the lake storage were used to equalize the flow, the above could be greatly increased.

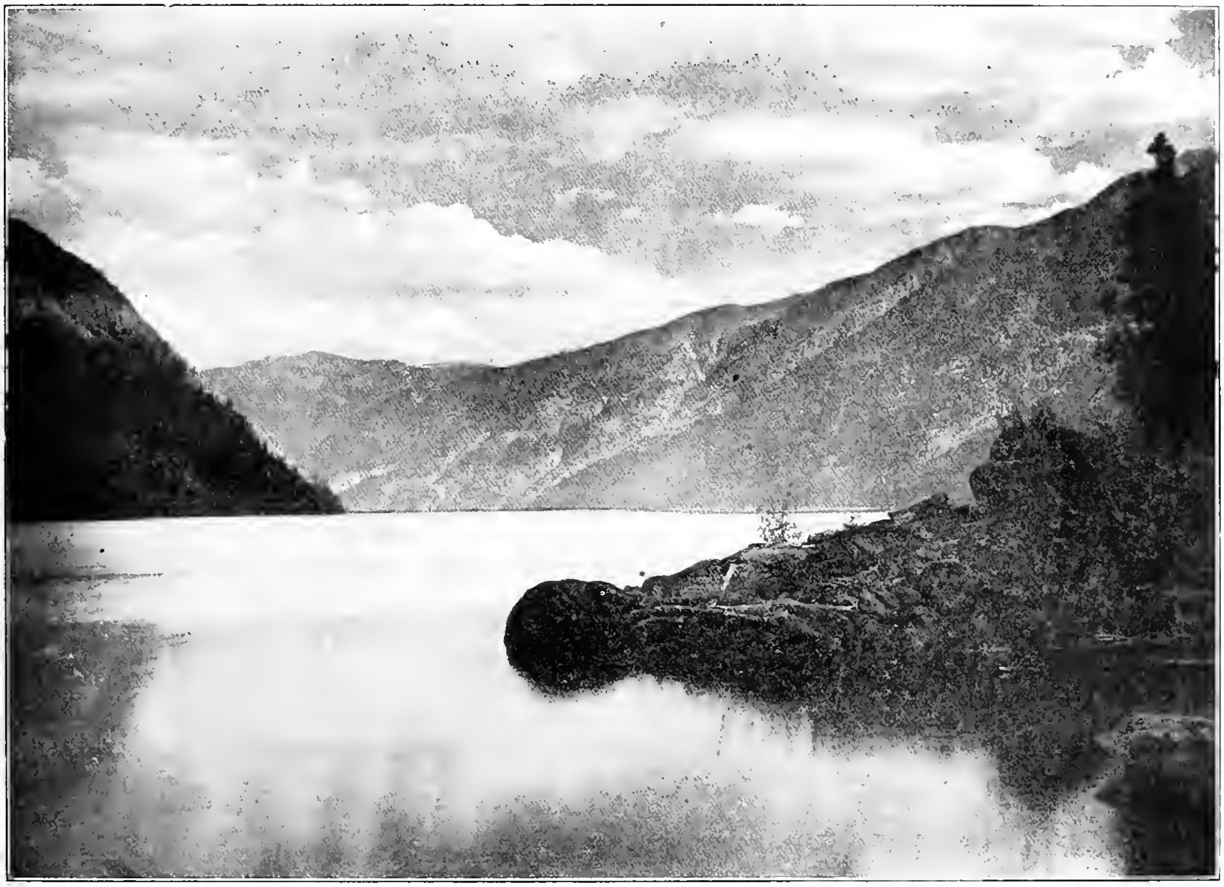
The minimum flow of the Wenatchee River is about 850 cubuc feet a second, only about 25 per cent of which is used for irrigation purposes, and that only in the lower valley. For 14 miles through the Tumwater canyon and before emerging into the agricultural valleys this stream is a raging torrent.

The Great Northern Railroad Company has almost completed a power plant at Chiwaukum, in the Tumwater canyon, where it will develop 10,000 horsepower with which to operate trains through the Cascade tunnel. There are yet great undeveloped power possibilities along the river, probably more than can be utilized for many years to come.

Since much of the water now used and much of the stored water later to be used in the Yakima Valley will be distributed to lands pretty well down the valley, it will be possible to develop a considerable amount of power from the water before it reaches the agricultural lands upon which it is to be used finally, and there is great need for such power for use in domestic industries and to be distributed over the densely populated irrigated districts for light and power.

There still remain opportunities to develop power along the lower Colville River, some of which are now in use. Large power installations have also been made along important streams in other parts of the State, particularly west of the Cascades.

West of Puget Sound, where the Olympic Mountains, with snow-capped peaks and heavy precipitation (100 inches a year), feed many small streams and rivers mostly within the National forests. Some of the streams fall several thousand feet in their rush to the ocean, affording many opportunities for power development.



Lake Chelan.

The streams winding their courses westward from the Cascade range through a jungle of forest and undergrowth furnish very many power sites. At some seasons of the year these rivers are torrents and at all times they carry large volumes of water. Already the great falls of some of them have been put under control and supply light and power to the coast cities and interurban electric lines. The development, however, has only commenced.

Other streams mentioned are the Okanogan, Entiat, Chelan, Walla Walla, Touchet and Snake Rivers and Mill Creek in the eastern and southeastern parts of the State.

WIRELESS TELEGRAPHY.[1]

BY GUGLIELMO MARCONI, D.SC., LLD.

The discoveries connected with the propogation of electric waves over long distances and the practical applications of telegraphy through space, which have gained for me the supreme honor of sharing the Nobel Prize for Physics, have been to a great extent the result of one another.

The application of electric waves to the purposes of wireless telegraphic communication between distant parts of the earth, and the experiments which I have been fortunate enough to be able to carry out on a larger scale than is obtainable in ordinary laboratories, have made it possible to investigate phenomena and note results often novel and unexpected. In my opinion, many facts connected with the transmission of electric waves over great distances still await a satisfactory explanation, and I hope to be able in this lecture to refer to some observations which appear to require the attention of physicists. In sketching the history of my association with radio-telegraphy, I might mention that I never studied physics or electrotechnics in the regular manner, although as a boy I was deeply interested in these subjects. I did, however, attend one course of lectures on physics under the late Professor Rosa, at Livorno, and I was, I think I might say, fairly well acquainted with the publications of that time dealing with scientific subjects, including the works of Hertz, Branly and Pighi.

At my home, near Bologna, in Italy, I commenced early in 1895 to carry out tests and experiments with the object of determining whether it would be possible by means of Hertzian waves to transmit to a distance telegraphic signs and symbols without the aid of connecting wires. After a few preliminary experiments with Hertzian waves I became very soon convinced that if these waves or similar waves could be reliably transmitted and received over considerable distances a new system of communication would become available, possessing enormous advantages over flashlights and optical methods, which are so much dependent for their success on the clearness of the atmosphere. My first tests were carried out with an ordinary Hertz oscillator and a Branly coherer as detector, but I soon found out that the Branly coherer was far too erratic and unreliable for practical work. After some experiments, I found that a coherer consisting of nickel and silver filings placed in a small gap between two silver plugs in a tube, was remarkably sensitive and reliable. This improvement, together with the inclusion of the coherer in a circuit tuned to the wave-length of the transmitted radiation, allowed me to gradually extend up to about a mile the distance at which I could affect the receiver.

Another, now well known, arrangement which I adopted was to place the coherer in a circuit containing a voltaic cell and a sensitive telegraph relay actuating another circuit, which worked a tapper or trembler and a recording instrument. By means of a Morse telegraphic key placed in one of the circuits of the oscillator or transmitter, it was possible to emit long or short successions of electric waves, which would affect the receiver at a distance and accurately reproduce the telegraphic signs transmitted through space by the oscillator. With such apparatus I was able to telegraph up to a distance of about half-a-mile. Some further improvements were obtained by using reflectors with both the transmitters and receivers, the transmitter being in this case a Righi oscillator. This arrangement made it possible to send signals in one definite direction, but was inoperative if hills or any large obstacle happened to intervene between the transmitter and receiver. In August, 1895, I discovered a new arrangement, which not only greatly increased the distance over which I could communicate, but also seemed to make the transmission independent from the effects of intervening obstacles.

This arrangement consisted in connecting one terminal of the Hertzian oscilator, or spark producer, to earth, and the other terminal to a wire or capacity area placed at a height above the ground, and in also connecting at the receiving end one terminal of the coherer to earth and the other to an elevated conductor.

I then began to examine the relation between the distance at which the transmitter could affect the receiver and the elevation of the capacity areas above the earth, and I very soon definitely ascertained that the higher the wires or capacity areas the greater the distance over which it was possible to telegraph.

Thus I found that when using cubes of tin of about 30 cms. side as elevated conductors or capacities, placed at the top of poles 2 meters high, I could receive signals at 30 meters distance, and when placed on poles 4 meters high, at 100 meters, and at 8 meters high at 400 meters. With larger cubes 100 cms. side, fixed at a height of eight meters, signals could be transmitted 2,400 meters all round.

These experiments were continued in England, where in September, 1896, a distance of 1¾ miles was obtained in tests carried out for the British Government at Salisbury. The distance of communication was extended to four miles in March, 1897, and in May of the same year to nine miles. Tape messages obtained during those tests, signed by the British Government officers who were present, are exhibited. In all these experiments a very small amount of electrical power was used, the high tension current being produced by an ordinary Rhumkoff coil. The results obtained attracted a good deal of public attention at the time, such distances of communication being considered remarkable.

As I have explained, the main feature in my system consisted in the use of elevated capacity areas or vertical wires attached to one pole of the high frequency oscillators and receivers, the other pole of which was earthed.

The practical value of this innovation was not understood by many physicists for quite a considerable period, and the results which I obtained were by many erroneously considered simply due to efficiency in details of construction of the receiver, and to the employment of a large amount of energy. Others did not overlook the fact that a radical change had been introduced by making these elevated capacities and the earth form part of the high frequency oscillators and receivers. Profgessor Ascoli, of Rome, gave a very interesting theory of the mode of operation of my transmitters and receivers in the Elettricista, Rome,

[1]The Nobel Prize Lecture, delivered December 11, 1909.

issue of August, 1897, in which he correctly attributed the results obtained to the use of elevated wires or antennas.

Professor A. Slaby, of Charlottenburg, after witnessing my tests in England in 1897, came to somewhat similar conclusions.

Many technical writers have stated that an elevated capacity at the top of the vertical wire is unnecessary.

This is true if the length or height of the wire is made sufficiently great, but as this height may be much smaller for a given distance if a capacity area is used, it is more economical to use such capacities, which now usually consist of a number of wires spreading out from the top of the vertical conductor.

The necessity or utility of the earth connection has been sometimes questioned, but in my opinion no practical system of wireless telegraphy exists where the instruments are not connected to earth. By "connecting to earth" I do not necessarily mean an ordinary metalic connection as used for ordinary wire telegraphs. The earth wire may have a condenser in series with it, or it may be connected to what is really equivalent, a capacity area placed close to the surface of the ground.

It is now perfectly well known that a condenser, if large enough does not prevent the passage of high frequency oscillations, and therefore in these cases the earth is for all practical purposes connected to the antennae.

After numerous tests and demonstrations in Italy and in England over distances varying up to 40 miles, communication was established for the first time across the English Channel between England and France in March, 1899. From the beginning of 1898 I had practically abandoned the early system of connection, and instead of joining the coherer or detector directly to the aerial and earth, I connected it between the ends of the secondary of a suitable oscillation transformer containing a condenser and tuned to the period of the electrical waves received. The primary of this oscillation transformer was connected to the elevated wire and to earth. This arrangement allowed of a certain degree of syntony, as by varying the period of oscillation of the transmitting antennae, it was possible to send messages to a tuned receiver without interfering with others differently syntonized.

As it is now well known, a transmitter consisting of a vertical wire discharging through a spark-gap is not a persistent oscillator, the radiation it produces is strongly damped. Its electrical capacity is comparatively so small and its capability of radiating energy so large that its oscillations decrease or die off with great rapidity. In this case receivers or resonators of a considerably different period or pitch are likely to be affected by it.

Early in 1899 I was able to improve the resonance effects obtainable by increasing the capacity of the elevated wires by placing adjacently to them earthed conductors, and inserting in series with the aerials suitable inductance coils.

By these means the energy storing capacity of the aerial was increased, whilst its capability to radiate was decreased, with the result that the energy set in motion by the discharge formed a train of succession of feebly damped oscillations. By a modification of this arrangement, excellent results were obtained.

In 1900 I constructed and patented transmitters which consisted of the usual kind of elevated capacity area and earth connection, but these were inductively coupled to an oscillation circuit containing a condenser, an inductance, and a spark gap, the conditions which I found essential for efficiency being that the periods of electrical oscillation of the elevated wire or conductor should be in time or resonance with that of the condenser circuit. The circuits consisting of the oscillating circuit and radiating circuit, were more or less closely "coupled" by varying the distance between them. By the adjustment of the inductance inserted in the elevated conductor and by the variation of the capacity of the condenser circuit, the two circuits were brought into resonance, a condition which, as I have said, I found essential in order to obtain efficient radiation.

Part of my work regarding the utilization of condenser circuits in association with the radiating antennae was carried out simultaneously to that of Professor Braun, without, however, either of us knowing at the time anything of the contemporary work of the other.

A syntonic receiver has already been shown, and consists also of a vertical conductor or aerial connected to earth through the primary of an oscillation transformer, the secondary circuit of which included a condenser and a detector, it being necessary that the circuit containing the aerial and the circuit containing the detector should be in electrical resonance with each other, and also in tune with the periodicity of the electric waves transmitted from the sending station.

It is also possible to couple to one sending conductor several differently tuned transmitters and to a receiving wire a number of corresponding receivers, each individual receiver responding only to the radiations of the transmitter with which it is in resonance.

At the time (12 years ago) when communication was first established by means of radio-telegraphy between England and France, much discussion and speculation took place as to whether or not wireless telegraphy would be practicable for much longer distances than those then covered, and a somewhat general opinion prevailed that the curvature of the earth would be an insurmountable obstacle to long-distance transmission, in the same way as it was, and is, an obstacle to signalling over considerable distances by means of light flashes.

Difficulties were also anticipated as to the possibility of being able to control the large amount of energy which it appeared would be necessary to cover long distances.

What often happens in pioneer work repeated itself in the case of radio-telegraphy—the anticipated obstacles or difficulties were either purely imaginary or else easily surmountable, but in their place unexpected barriers manifested themselves, and recent work has been mainly directed to the solution of problems presented by difficulties which were certainly neither expected nor anticipated when long distances were first attempted.

(TO BE CONTINUED)

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CONTENTS

The Science of Appraising

Appraisers seldom agree as to the value of a public service plant. This is not because of individual bias, but is due to the lack of a uniform basis of valuation. Recently it has become customary to calculate rates for public utilities and to levy taxes on the companies furnishing them upon the estimated worth of the property. This estimate is often made by an arbiter, an engineer whose wide experience in designing, installing and operating such plants has qualified him to act in this capacity. If it were possible to assemble and co-ordinate the experience of a number of such arbiters, we would have the foundation upon which to build a new science, that of appraising.

Analysis shows that the value of any business is dual—the corporeal and the incorporeal. In bookkeeping, these are written as "furniture and fixtures" and "good will." In a public utility plant they are represented by the physical value and the franchise and going values. The first is tangible and readily calculated from the cost of replacing a similar plant, less the depreciation. The last two, being intangible, have been the bone of bitter contention.

It is frequently argued that a franchise, being a license gratuitously granted by the people, should not be capitalized by a corporation because the increased cost of service compels the people to pay the fixed charges on what was formerly their own property. But as the corporation pays taxes on its franchise, it feels justified in calling it an asset. The investment is made "not in the franchise, but under the franchise, and in the faith thereof." The courts have repeatedly recognized the franchise as property whose value depends upon its earning power. An average of many franchise valuations has been estimated by Henry Floy to be about one-third of the actual replacement value of the corporation's assets.

Finally, there is the going value, which is represented by an established or operating business, as distinguished from one that is merely ready for business. The part occupied by this element in the appraisal of public utility properties is admirably expressed elsewhere in this issue by Mr. William H. Bryan. His paper is largely concerned with a comparison of the rulings of the Wisconsin Commission and the suggestions in a previous paper by John W. Alvord. These differ essentially in their definition of the going value, the Commission's rulings being based upon the expenditure necessary to obtain a similar business and to cover losses until the plant is self-supporting, and Mr. Alvord's findings upon the cost of reproducing the gross income of an existing plant. Mr. Bryan suggests that some less logical, but shorter method, will meet with more general approval, and recommends that some definite percentage be adopted as a basis of valuation.

From the above it will be noted that the present tendency is toward an arbitrary standard. Such empirical rules are typical of all incomplete sciences. They suffice until better are found.

PERSONALS.

A. M. Hunt, consulting engineer, spent the past week in Southern California.

Thomas Mirk, of Hunt, Mirk & Co., is visiting San Diego, on engineering business.

Russell Dunn has been appointed City Engineer of San Francisco by Mayor P. H. McCarthy.

R. B. Daggett, manager Pacific Coast offices of the Electric Storage Battery Company, left San Francisco this week for a trip East.

C. P. Baird, president of the King City Water, Light & Power Company, spent the Christmas holidays in San Francisco.

C. L. Cory recently returned from a week's trip through Southern California, including Los Angeles and the Imperial Valley.

Edgar C. Gribble, chief electrician of the Fairmont Hotel, also has charge of the new plant of the Palace Hotel in San Francisco.

R. D. Holabird has returned to San Francisco from the East where he reports that business is showing great improvement.

Frank Thurber, superintendent of the San Jose Railway Company, came up to enjoy New Year's Eve and was a guest at the Palace.

Henry Parsons, superintendent of the San Jose, Los Gatos & Interurban Railway, of San Jose, spent Christmas in San Francisco.

A. G. Wishon, manager of the San Joaquin Light & Power Company, has returned to Fresno after spending Christmas and New Year's in San Francisco.

H. H. Sinclair, vice-president and general manager of the Great Western Power Company, left San Francisco for the East on December 29th for a short business trip.

Russell Walden, manager of the California Electrical Construction Company, who has been confined to his home by illness for the past four months, is now convalescent.

G. H. Hall has recently been transferred from the Boston office of the Sprague Electric Company to the motor and generator department in the general office, New York City.

"King" Haley, formerly a foreman at the Union Iron Works, is the new chief engineer at the Hotel St. Francis, San Francisco, taking the place of Chas. G. Hightower, resigned.

Arthur N. Cantril, formerly with the Denver Gas and Electric Company, and more recently with the Pueblo Gas Company, has been made general manager of the Spokane Gas Light Company, which was recently acquired by the Doherty interests.

F. A. Richards has been appointed manager of the car department of Pierson, Roeding Company of San Francisco, Pacific Coast agents for the J. G. Brill Company, vice O. L. Williams resigned. Mr. Richards will arrive in San Francisco before the end of January.

G. A. Richardson, who has for the past five years been superintendent of the Houghton County Traction Company, recently resigned to accept the position of traffic manager of the Seattle lines. As a testimonial of their regard, the trainmen of the company presented Mr. Richardson with a handsome remembrance.

A. C. Sprout has returned to San Francisco from Dunsmuir, where he was engaged as engineer in connection with the installation of electric power transmission apparatus in the Southern Pacific Company's shops. An extension of the Siskiyou Electric Light & Power Company's transmission lines was made in order to secure a supply of power.

NEW CATALOGUES.

Smith-Booth-Usher Co., 212 S. Los Angeles street, Los Angeles, Cal., are distributing a pamphlet that shows the saving in power effected by using the International Amet Oil Gas Producer.

The Fritchle Automobile and Battery Company, Denver, Colo., has issued a well-illustrated booklet describing in detail a 2140-mile tour made in a Fritchle "100-mile" electric vehicle in winter from Lincoln, Nebr., to New York City, thence to Washington, D. C.

Holophane Illumination for December, 1909, from the Holophane Company contains useful data on lighting auditoriums, garages and windows. Announcement is made that hereafter the metric system is to be adopted in all publications from this company.

Circular No. 1506 from the Westinghouse Electric & Mfg. Co. consists of an interesting and valuable paper on "Recent Types of Arc Lamps and Their Operation," by C. E. Stephens, This paper was read before the National Electric Light Association Convention in June, 1909.

Bulletin No. 117 of the Bristol Company, Waterbury, Conn., describes and illustrates recording gages for pressure and vacuum and also water-level gages. In these gages there are no multiplying devices, the recording pen arm being attached directly to the pressure tube.

A little folder, No. 3884, recently issued by the General Electric Company, is interesting inasmuch as it compares the Tungsten and carbon sign lamps, and shows plainly the advantages to be derived by the use of the former. It describes also the manner in which an ordinary sign may be transformed into an illuminated sign.

In a n attractive pamphlet "The Dawn of a New Era in Lighting," the General Electric Company takes up the history of light from the tallow dip to the tungsten lamp. The comparison of cost of this with other illuminants is taken up in detail. The pamphlet, which is numbered 3885, should be of interest to both the producer and consumer of current.

A new and enlarged edition of "Feed Water Filtration" is being distributed by James Beggs & Co., 109 Liberty street, New York. This book explains how oil, dirt, etc., get into feed water, what damage they do within the boilers, and how to remove such impurities before they can occur. The Blackburn-Smith Feed Water Filter and Grease Extractor is described in detail.

The Westinghouse Diary for 1910 from the Westinghouse Elec. & Mfg. Co. maintains the high standard set by its predecessors. Substantially and handsomely bound in tan leather its 96 pages of condensed electrical data, arranged for convenient reference, is invaluable to the engineer. The diary for 1910 and the maps of the world which are included continue to make it a most useful pocket companion.

Bulletin No. 4705, devoted to the Curtis Steam Turbines for low pressure and high pressure has been issued by the General Electric Company, and contains considerable information which should be of interest and value to the central station manager. As the subject indicates, the publication deals with turbines of both the low pressure and the mixed pressure types, and those with horizontal and with vertical shafts.

The Ohio Brass Company December bulletin is devoted to electric railway and mine haulage material. The feature of this issue is an abstract of the paper on the Cascade Tunnel electrification, presented before the American Institute of Electrical Engineers by Dr. Cary T. Hutchinson. The Ohio Brass Company designed the overhead construction and manufactured all the overhead material used for this installation. This bulletin also contains an illustrated description of the company's factory.

NEWS OF THE STATIONARY ENGINEERS

PREAMBLE.—This Association shall at no time be used for the furtherance of strikes, or for the purpose of interfering in any way between its members and their employers in regard to wages; recognizing the identity of interests between employer and employe, and not countenancing any project or enterprise that will interfere with perfect harmony between them.

Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the business of the Association, and at all times preference shall be given to the education of engineers, and to securing the enactment of engineers' license laws in order to prevent the destruction of life and property in the generation and transmission of steam as a motive power.

California.

No. 1. San Francisco, Thursday, 172 Golden Gate Ave. Pres., P. L. Ennor. Sec., Herman Noethig, 816 York St.

No. 2. Los Angeles. Friday, Eagles' Hall, 116½ E. Third St. Pres., J. F. Connell. Fin. Sec., Harry Notthoff, 1307 Winfield St. Cor. Sec., W. T. W. Curl, 4103 Dalton Ave.

No. 3. San Francisco. Wednesday, Merchants' Exchange Bldg. Sec., David Thomas, 914 O'Farrell St.

No. 5. Santa Barbara. Geo. W. Stevens, 2417 Fletcher Ave., R. R. No. 2.

No. 6. San Jose. Wednesday. Pres., W. A. Wilson, Sec., Lea Davis, 350 N. 9th St.

No. 7. Fresno. Pres., A. G. Rose. Sec., E. F. Fitzgerald, Box 651.

No. 8. Stockton. Thursday, Masonic Hall. Sec., S. Bunch, 626 E. Channel St. Pres., H. Eberhard.

Oregon.

No. 1. Portland. Wednesday, J. D. Asher, Portland Hotel. Pres., B. W. Slocum.

No. 2. Salem. A. L. Brown, Box 166.

Washington.

No. 2. Tacoma. Friday, 913½ Tacoma Ave. Pres., Geo. E. Bowman. Sec., Thos. L. Keeley, 3727 Ferdinand St., N., Whitworth Sta.

No. 4. Spokane. Tuesday. Pres., Frank Teed. Sec., J. Thos. Greeley, 0601½ Cincinnati St.

No. 6. Seattle. Saturday, 1420 2d Ave. Pres., H. R. Leigh. Sec., J. C. Miller, 1600 Yesler Way.

Practical letters from engineers and news items of general interest are always welcome. Write your items regardless of style. Communications should be addressed to the Steam Engineering Editor.

PRACTICAL MECHANICS.

Paper No. 2—Names and Terms.

In order that we may be intelligently understood in the use of certain technical terms and expressions it will be well to bear in mind the following definitions:

Velocity—Theoretically this term is used to denote the rate of change of position of a moving point. Velocity implies direction, as well as quantity of motion. It may be either variable or constant.

When constant we denote the velocity as uniform motion and usually express it in terms of feet per second. In this case the distance passed over in a given time divided by that time gives the velocity e. g. 10 ft. traversed in 5 secs. equals velocity of $\frac{10}{5}$ or 2 ft. per second.

When the velocity is not constant we may divide the space passed over in a very short time by that time interval, and thus obtain the average velocity for the instant concerned, as for instance 0.3 ft. traversed in 0.1 sec. $= \frac{0.3}{0.1} = 3$ ft. per sec., the velocity for that particular tenth of a second.

Mathematically this reduction of the time and space values may be continued until the quanities become infinitesimal. These are then summated or integrated, as it is called to ge a general expression for the velocity. The numerical value at any instant is then found by substituting the known quantities in this general expression. This value really is the length that would be passed over in the next unit of time if the law of change for speed and direction were at that instant interrupted. This extreme exactness is rarely necessary, in the study of mechanism, and will not be further discussed here.

Velocitites may be classified as linear and angular, either type of which may be constant or variable.

By *linear velocity* is meant the rate of motion in a uniform direction along any straight line.

By *angular velocity* is meant the rate of motion of a point at a unit distance from the center of angular motion. Angular velocity is expressive therefore in terms of the angle swept out during the time interval considered. An arc of a circle equal in length to the radius of the circle is called a radian. Calling the ratio of circumference to diameter, π then since the diameter is twice the radius, there are 2π radians in every circle. Now, if the radius of the circle be taken as unity then a velocity of 2π radians per sec. is equal to one revolution per second.

Velocity-ratio is the term used to denote the ratio of two linear or two angular velocities or, in some cases of a linear and an angular velocity.

Revolution is the designation for a complete turn while rotation applies to any portion of a turn and has to do with the direction of the turn.

Driver and *follower*—In any elementary combination of mechanism one piece always drives the other, the one therefore being called the driver and the other the follower.

Directional relation—This term has reference to the relation of the directions of motion of driver and follower. If one never reverses its direction of motion unless the other does also, the directional relation is constant, otherwise it is said to be variable.

MOTION.

Kinds of Motion—In general the position of a body in motion is known if the positions of three of its points are known. If, now, one of these three points is fixed in space the motions of all other points are at once limited to the surfaces of concentric spheres. This is known as Spheric Motion. The application of spheric motion to mechanics is in this general case, rare; but if we consider the fixed point as removed infinity, that is, such that any finite portions of the concentric spheres become planes, we have a very common form of application. This is called Uniplanar Motion. The majority of machine motions are of this type, and the solution of these problems involves only plane geometry, all calculations being referred to a reference plane.

KINDS OF UNIPLANAR MOTION.

Uniplanar Motion consists of either *Pure Rotation*, or *Rectilinear Translotion*, or both.

Pure Rotation is the motion resulting when in addition to fixing one point at infinity the body is still further constrained by fixing a second point in the reference plane, or at any finite distance from it. In this case all other points in the body travel in a system of concentric circles about the line connecting the two fixed points.

Rectilinear Translation is the motion resulting if the second fixed point above discussed is removed to infinity in any direction other than at right angles to the reference plane.

The concentric circles then become, within any finite space, a system of straight lines parallel to the line of intersection of the two reference planes.

Some illustrations may serve to aid the understanding of this development and classification of motion. The old familiar fly-ball engine governor would, if the arms were pivoted at the center of the axis of rotation, or of the spindle, be a case of spheric motion.

The movement of a ship at sea is practically uniplanar motion since the center of the earth (the fixed point removed to infinity) is sufficiently removed from the sea-level to give the surface the appearance of a plane.

If now a moving ship at sea be constrained by a tight rope attached to some fixed point, as an anchor, its motion can be only in a circle about the anchor or really about the axis extending through the center of the earth and the anchor. This is pure rotation.

Now extend the rope several miles to a shore anchorage, then any brief motion of the ship will be possible only in a straight line at right angles to the direction of the rope. This will be a case of rectilinear translation.

In dealing graphically with problems in uniplanar motion it is convenient to make use of a system of diagraming and notation known as the rectangular co-ordinate system. In this system two axes of reference are assumed intersecting in a point.

This point is called the origin and is usually designated by the letter (O). One axis extending up and down the paper is called the ordinate or (Y) axis. Values up are taken as positive and those down as below O, are negative. The other axis at right angles to the Y axis is called abscissa or (X) axis. Values to the right of O are positive and to the left negative.

THE INSTANTANEOUS CENTER.

In a body moving with uniplanar motion suppose the direction of motion of two of its points is known. Now erect perpendiculars to these lines of direction at the points considered. The intersection of these perpendiculars will be a point about which the body is for the instant rotating. This point is called the instantaneous center.

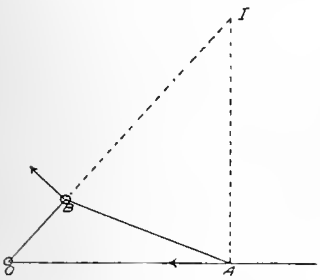


Fig. 1.

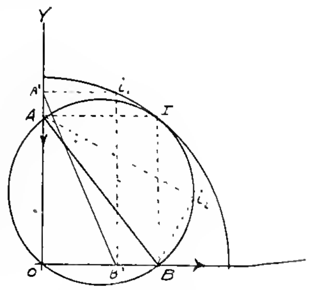


Fig. 2.

Suppose (O B) in Fig. 1 to represent an engine crank with shaft at O. Let A B represent the connecting rod. The arrows as drawn indicate the directions of motion of the two points of the rod A and B at the instant under consideration. Perpendiculars to these two directions of motion are shown intersecting at I the instantaneous center and the connecting rod is at that instant moving as though turning about I as a center.

This point may be easily determined for any series of positions, and if these positions are chosen sufficiently close together the successive position of the instantaneous center will become a curve. This curve is called the centrode of motion. Depending upon whether the motion is based upon fixed axes in space or upon axes fixed in the body itself the centrodes become fixed (space) centrodes, or body (moving) centrodes. An example of this is the following: See Fig. 2.

Consider the line A B whose extremities are constrained to move along the axes O Y and O X. By plotting successive positions of the instantaneous center it will be found that the fixed centrode is a circle of radius equal to A B and with center at O. By further plotting with reference to the line A B the successive positions (*i. e.* as i_2 instead of i_1) taken up by the instantaneous center the moving centrode is found to be another circle A O B, whose diameter is one-half that of the fixed centrode. This circle rolls on the inner side of the fixed centrode as the line A B assumes its various positions. Every point of the circumference of the moving centrode describes a diameter of the fixed centrode. This is a straight line hypocycloid.

SAN FRANCISCO, NO. 1.

The National Association of Stationary Engineers, San Francisco, No. 1, held an informal smoker and house warming in their new hall at 172 Golden Gate avenue, on the evening of December 30th. The president of San Francisco No. 1, Mr. P. L. Ennor made the opening address and extended a cordial welcome to all present and to partake of the hospitality of this association. At this social gathering there was present the sister Association, California No. 3, with many of their officers and members. The following contributed their services for the above function: Mr. Ed. Healey, the famous and congenial comedian; R. H. Hunt, the Bohemian Kid; Chas. H. S. Pratt with his songs and recitation lubricated with axle grease; Cecil C. Cline, song and cornet solo; Frank Willard, song and story; Ray Broulette, pianist and songs. Speeches were made by the following: Past President, J. W. Maher, of San Francisco No. 1; W. N. Munroe, president of California No. 3; David Thomas, C. C. Elsasser, our genial manager of the late Mechanics' Fair; Mr. Matthews, J. L. Davis, James Carr and many others. Notwithstanding the inclement weather, it was in the wee small hours of the morning before the guests repaired to their respective homes.

H. W. NOETHIG.

QUESTION BOX.

Question: In putting in a new shaft, give a brief rule for adjusting the eccentric.

Answer: Put the crank on its top center with the valve at its proper lead at the top. Next fasten the sheave with set bolts to keep the valve lead secure; when all is connected, then, after a turn of the engine, see if the valve has the proper lead at the bottom when the crank is on the bottom center. If such is the case, mark the key ways and key on the sheave.

Question: Give a simple rule for finding the total heat in steam and an example of same.

Answer: Multiply temperature (or sensible heat) of the steam by .3 and add it to 1115°.

100 lbs. by the gauge is 115 gross, the 15 being approximately the weight of the atmosphere, and 115 gross has (by a reference to steam tables) 338° of heat, hence:

$$338 \times .3 = 101.4 + 1115° = 1216.4 = \text{total heat}$$
$$338.0 \text{ sensible heat}$$
$$878.4 \text{ latent heat.}$$

Question: What gain is there in using steam at 100 lb. and by expansion making the mean effective pressure 70 lb. over, using steam of 70 lb. throughout the entire stroke?

Answer: Using a cylinder with a volume of 1 cubic foot, and an initial pressure of 70 lb. continued throughout the stroke, would be using, at each stroke, a cubic foot of 70 lb. steam, or a weight of .201 lb. Should the initial pressure be 100 lb., a cut-off of ⅜ cubic feet therefore equals .099, so that only .099 lb. would be used, against .201 lb. of the lever pressure steam, as in the first case. Thus, by working steam expansively, you have a gain of .201—.099=.102 lb. at each ½ stroke.

Question: What is the best ratio of areas for a steam pump?

Answer: The steam piston should have about 2¾ times the area of the water piston. There being no mechanical purchase in favor of the steam piston, it must have the greater area of the two, otherwise the pressure on the water piston would equal the pressure on the steam piston and the pump would refuse to work.

Question: What is meant by the number of an indicator spring?

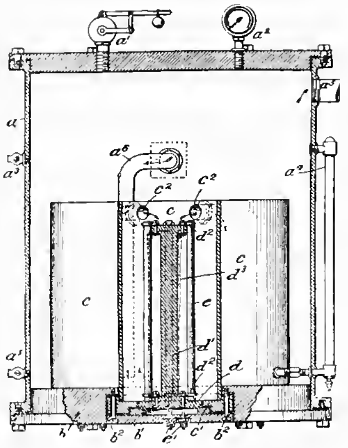
Answer: The number marked on a spring (several of which are furnished with each indicator) is designed to show the number of lb. steam pressure on the boiler at which it is to be used; thus, a 30 lb. spring is one in which a pressure of 30 lb. will cause the piston inside the indicator to rise one inch above the atmospheric line of the diagram.

TRADE NOTES.

An important decision was rendered on November 12th by the U. S. Court of Appeals for the First Circuit, sustaining the Thalacker patent 502,541 which covers substantially all forms of indicating enclosed fuses. In the opinion of the court, as stated by Judge Lowell, "The gist of the Thalacker patent consists in the combination with these old elements (the main fuse and its casing) of an auxiliary fuse whose condition is at all times conveniently observed, so that by reasonable inference the condition of the main fuse may be known." The court held "The invention goes beyond the mere details shown and the patent should receive a construction correspondingly broad." The above decision was rendered in the suit brought by the General Electric Company against Fred B. Smith, sales agent for the Sachs fuses.

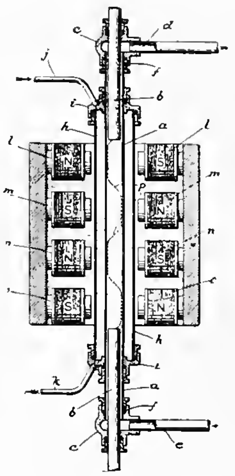
PATENTS

944,050. Electrical Steam-Generator. Eleazer I. Rains, New York, N. Y. An electrical steam generator, comprising a common shell or casing, a plurality of independent water containers therein, each adapted to receive and hold a body of water separate from and independent of that in each of



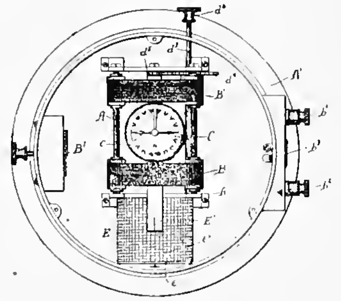
the other containers, and communicating with a common steam space, and a plurality of independent electrical heating elements distributed in the several water containers, whereby the water in each container may be heated independently of that in the other containers.

943,661. Production of Oxids of Nitrogen from the Air. Francis I. du Pont, Wilmington, Delaware, assignor to She E. I. du Pont de Nemours Powder Company, Wilmington, Del. An apparatus for producing oxids of nitrogen from the air, comprising in combination a cooling surface, which is a



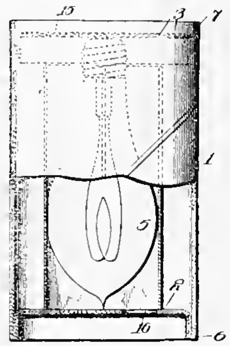
non-conductor of electricity, in contact with which the air to be acted on is adapted to pass, electrodes between which an arc longitudinally with respect to said surface is adapted to be produced, and a plurality of oppositely placed rotary magnetic fields extending longitudinally between the electrodes.

944,459. Instrument for Locating Grounds and Breaks in Electric Circuits. Matthew J. Myers, Syracuse, N. Y. In an instrument for locating an unknown portion of a circuit to be tested, the combination of oppositely-acting magnetizing members adapted to be connected respectively to the branches of the circuit, a magnetizable member subject to the differential influence of the magnetizing members, said magnetizable member being movable automatically relatively to the magnetizing members, means for varying the relative position of



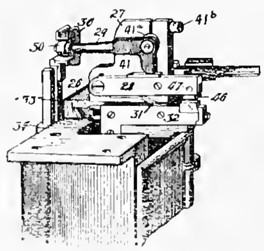
the magnetizing and magnetizable members, and means controlled by the variation of the relative position of the magnetizing and magnetizable members for indicating the position of the unknown portion of the circuit.

944,616. Package for Frangible Articles. Charles F. Jenkins, Washington, D. C., assignor to Single Service Package Company. In a package for frangible articles the combination of a body portion; a pair of flanged, cup-shaped closures



therefore having their flanges pointing in the same direction and fitting the interior surface of said body portion; and an angular container also fitting the interior of said body portion and resting between said closures, substantially as described.

943,861. Electric-Welding Machine. Alvin E. Buchenberg, Toledo, Ohio, assignor to The Toledo Electric Welding Company, Toledo, Ohio. In a machine of the class described, the combination of a plurality of work-gripping levers, and



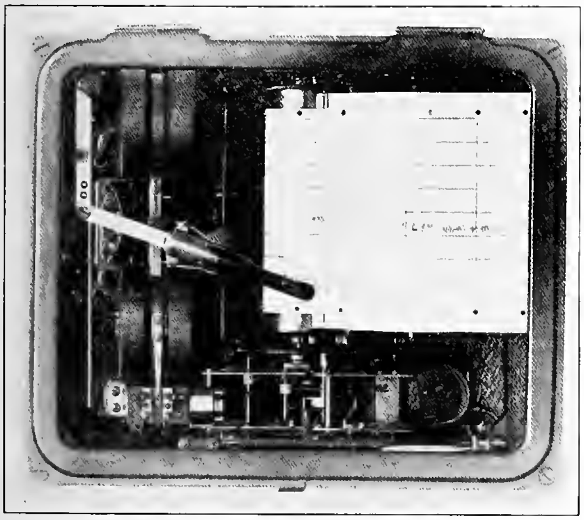
mechanism movable to effect a positive oscillation of the levers in unison to grip the work and capable of permitting differential movements of the levers as the varying thickness of the work may require.

INDUSTRIAL

HOW GRAPHIC-METER ANALYSIS OF SUB-STATION LOAD RENDERED POSSIBLE REDUCTION IN GENERATING EQUIPMENT.

An example of the value of the graphic recording meter for analyzing power loads was recently shown in a sub-station which supplies power to the terminal yards of a large railroad system. In this instance, as a result of the application of the meter, it was found possible to reduce the capacity of the machines operating by more than half, thereby diminishing operating expenses and improving the efficiency and load factor of the remaining generating equipment.

The sub-station referred to contains one 37½ k. w. and two 25 k. w. motor generator sets. These supply direct current at 250 volts to three turntables and one small crane. Each of the turn tables is driven by a 22 h. p. series motor with rheostat controller, and is capable of turning a locomotive 180 degrees, or end for end, in one minute. The crane is about five tons capacity and subject to very intermittent service, so that its operation has little effect on the total station load.



Westinghouse Graphic Recording Meter.

The turntables are held ready for service at all times. Rush hour periods occur in the morning and evening, and at these times the tables are usually very busy. A locomotive to be turned goes to the nearest unoccupied table, and in this way it is rarely the case that the two turntables are started at once, although two or three may be in operation at the same time.

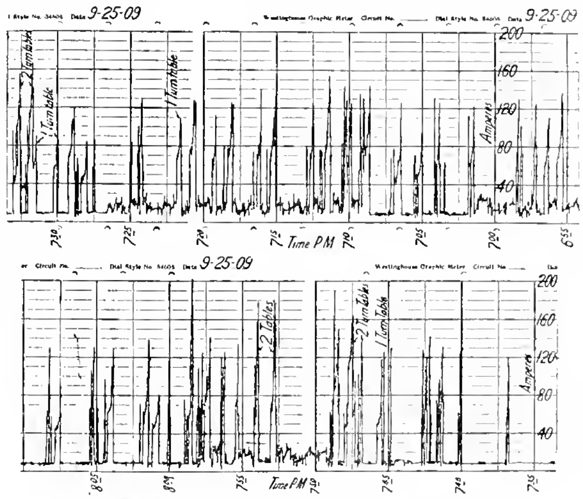
Before the study of the actual load conditions had been begun, it was customary to operate all three motor generator sets during the rush hours. At these times the violent oscillation of the needles of indicating meters on the generating panels, striking against the stops, seemed to indicate that more generating capacity was needed. In order to determine this latter question definitely, a Westinghouse graphic recording meter was obtained and inserted in the main feeder. The tests covered a week's careful study, during which time the load on the station was continuously recorded. That section of the curve reproduced herewith was secured during one of the rush periods. To obtain a clear record, a paper speed of 24 inches per hour was used.

The record shows that the average peak encountered during the starting of a turntable is 120 amperes. This drops to a value of from 50 to 70 amperes during operation, after the table has been accelerated. The maximum peak noted was about 180 amperes at the time of starting two turntables simultaneously.

As the full load current of the 37½ k. w. motor generator set alone is 150 amperes, it becomes very clear that the existing station capacity is ample to handle the present service besides a large future increase.

Since the tests it has been found necessary to operate only the one largest unit, and the former practice of running all three sets as accordingly been discontinued. The result has been improved operating economy, efficiency and load factor.

This example thus cites an instance where, in spite of a suspected insufficient station capacity, it was demonstrated that less than half the equipment already installed was needed for the existing demand. The graphic indicating meter is equally impartial in showing up overloaded apparatus, and often performs valuable service in indicating unsuspected load conditions which give rise to excessive heat-



Graphic Meter Record of Motor Driven Locomotive Turntable Loads.

ing and impaired regulation and efficiency, the cause of which cannot otherwise be traced.

The important results obtained from graphic meter analysis of motor driven machines and apparatus have been repeatedly shown. Loss of time has been eliminated, and the productiveness of both machine and operator largely increased as a result of the definite location of "low spots" in the motor load curve.

Experience has proven that in almost every power operation there may be considerable unknown and unnecessary losses, which may be promptly localized by analyzing the graphic meter curve, and remedied with resultant increased production or decreased operating expense.

TRADE NOTE

The Western Electric Company is making rapid progress with the installation of the power generating plant for the St. Francis Hotel. The plant will consist of four Western Electric, three-wire, direct-current generators, with a combined capacity of 825 k. w., controlled by switchboards of the remote controller type.

NEWS NOTES

FINANCIAL.

SPOKANE, WASH.—Directors of Washington Water Power Company have asked to increase stock $5,000,000. Action will be taken March 15 next.

SACRAMENTO, CAL.—The Board of Trustees has ordered the judiciary committee to prepare the necessary ordinance calling for a bond election to raise $666,000 for a filtration plant on the Mull Tract.

NEWPORT, CAL.—At a special election this place voted $49,000 in bonds for water works and $25,000 for gas works. The city will take over the plans and system of the Newport Water Company, and Home Gas & Electric Company.

NAPA, CAL.—Bids are being received at the office of the Napa City Water Company for the purchase of $22,500 20-year 5 per cent semi-annual first mortgage bonds, by W. G. Thompson, secretary. Accrued interest to be paid by purchaser.

TACOMA, WASH.—The City Council has ordered a special election to pass upon the Green River water supply as the best proposition of supplying Tacoma with a gravity system. It will require the issue of over $2,000,000 in bonds to finance the new system.

ST. HELENS, ORE.—The water commission at its last meeting entered into a contract with Morris Bros. of Portland, for floating $40,000 of water bonds, proceeds to be used for the construction of a water system. The bonds draw six per cent interest and sold at par.

SAN FRANCISCO, CAL.—The proposals to issue bonds to the amount of $1,900,000 for the construction of a municipal electric railway on Geary street and $120,000 for a similar road on Market street from Sutter to the ferry carried at the election December 30th.

SAN FRANCISCO, CAL.—The City Electric Company has decided to pay a monthly dividend of 25c per share of issued stock of par value of $100. The company's plant began operations November 15, 1907, and its capacity has just been increased by the installation of a 12,000 k. w. steam turbine generator.

PASADENA, CAL.—A resolution declaring that the interests of Pasadena demand municipal ownership of water plans was passed at a special meeting of the City Council last week. An ordinance calling for a bond election for $1,200,000 of either 4½ or 5 per cent bonds and setting the date of the election either January 26th or between that and February 1st, will be passed. Prices to be paid for three water companies are: Lake Vineyard, $386,000; West Side, $301,000; North Pasadena, $131,000. In addition to this the bonds will cover $200,000 betterments.

INCORPORATIONS.

ROSWELL, N. M.—Grant Oil & Gas Co. of Roswell, $1,000,000.

SPOKANE, WASH.—Washington Southern Tel. Co. of Spokane, $100,000, by C. M. Cooley, L. V. Gray, C. N. Thomas, C. R. and D. V. Cushman.

LA MESA, CAL.—Cholla Mutual Water Company, with a capital of $4000. The company has incorporated for mutual benefit of residents and property owners in the Stenger tract. Directors are C. C., H. C. and D. F. Park, W. L. Maxwell, etc. all of La Mesa. Principal place of business is at La Mesa.

MARSHFIELD, ORE.—Articles of incorporation have been filed with the county clerk by the Union Traction and Terminal Company, organized to build car lines in North Bend and Marshfield, also connecting the two cities. Incorporators are: J. M. Blake, G. W. Kaufman and R. O. Grages; capital stock, $1,000,000.

CITY OF MEXICO.—The Guadalajara Gas, Operating & Construction Co. has been organized in Los Angeles, Cal., to take over concession for a gas plant in Guadalajara secured by J. Guillermo Dominguez. H. W. Burkhart is vice president and general manager of the new company. Work will be started early in the new year. H. N. Sessions, a Los Angeles gas and electrical engineer, is responsible for the organization of the new company.

TRANSMISSION.

SPOKANE, WASH.—Spokane & Inland Empire Company, will construct new transmission lines from Greenacres to Coeur d'Alene and Hayden Lake.

ENTIAT, WASH.—George Brown of Chelan Falls and J. G. Kennedy of Waterville are soon to start work on their new power plant at the mouth of the Entiat.

BOISE, IDADO.—It is reported that the Western Electric Company is surveying a site for a power dam on the Snake River at Halls Falls, west of Mountainhome.

CHICO, CAL.—The Sacramento Valley Power Company has a large force of men setting poles and placing wires for the line between Chico and Redding. The line is eighty miles long, and will be completed about January 1st.

AUBURN, CAL.—The Hydro-Electric Company's plant at Horseshoe Bar on the American River was recently completed. This plant is owned personally by John A. Britton. It will furnish power for mining and other industries in the vicinity of the plant.

KALISPELL, MONT.—After much arbitration a compromise was reached by the Northern Idaho & Montana Power Company and the City Council of Columbia Falls and a fifty year franchise for the furnishing of electric light to the city was granted the company.

TWIN FALLS, IDAHO.—The City Council has granted a blanket franchise to the Twin Falls Electric Railway, Light & Power Company, of which F. D. Kimball is the head carrying the right to erect poles, etc., for the distribution of electric light and power within the city.

SAN FRANCISCO, CAL.—Proposals will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., up to January 18, 1910, and publicly opened immediately thereafter, to furnish at the naval training station, San Francisco, one centrifugal pump and motor.

REDDING, CAL.—The Mountain Copper Mining Company has taken its most decisive step, just closing a contract with the Northern California Power Company, to build a new and heavy power transmission line from this city to the Keswick smelter. The line will be bigger than the one to Kennett and will be constructed at a cost of $150,000.

NEW YORK.—The Mexican Northern Power Company, held a meeting in Montreal in November and increased its capital stock. The company has obtained valuable concessions for the erection on the Conchas river in Chihuahua, Mexico, of extensive hydroelectric and irrigation projects. An immense dam will be constructed, which will probably be the largest in the world. There will be two transmission lines, one to the city of Chihuahua and one to Parral. C. F. Greenwood is president and E. G. Greenshield is vice president of the company.

SALT LAKE, UTAH.—With the expressed intention of increasing the height of the dam known as the Gunnison reservoir dam, to ten feet, and to store all surplus and unappropriated waters of the Saupitch River and Six-mile Creek, Frank L. Capening of Provo has filed an application asking the right to appropriate from these streams 5,000 acre-feet of water. Under the application an area of 5000 acres in Sanpete County will be irrigated.

LODI, CAL.—Geo. E. Lawrence, chairman of the Board of City Trustees, is now in San Francisco negotiating with the different power companies relative to purchasing electric current by the city of Lodi. It has been stated on good authority that the American River Company is willing and anxious to furnish the city with light and power. The city has the money needed for a municipal system of light, power, water and sewerage, and if necessary a plant will be erected to generate electricity and pump water. The Trustees prefer, however, to purchase the current if satisfactory arrangements can be made with some company.

ILLUMINATION.

SIERRA MADRE, CAL.—The City Council has ordered the City Clerk to publish notice of the sale of the gas franchise applied for by S. S. Forney.

SANTA BARBARA, CAL.—The local lighting plant will make improvements in the old Merchants' Mutual plant and bring it up to the standard of plant now known as Edison No. 1.

LOS ANGELES, CAL.—The Board of Trustees has adopted a resolution to install four miles of additional street lighting service and 80 lights with copper service wire and tungsten lamps at a cost of $11,600.

CHEHALIS, WASH.—The City Council has passed an ordinance granting to W. W. Seymour and F. C. Brewer the right to erect and operate pipes in the streets for the transmission of heating and illuminating gas.

EUGENE, ORE.—Plans have been outlined by Manager J. H. Hartog, of the Commercial Club, for the augmentation of of the street lighting system of the city. Hartog has secured a contract with the Northwestern Corporation.

SAN MATEO, CAL.—Mr. Cunha's application for a franchise for an electric lighting system for the coast side has been brought up again by Archer Kinkaid and the necessary resolution has been passed ordering bids to be advertised for.

ALAMOGORDO, N. M.—Geo. Carl, proprietor of the Alamagordo ice factory, has formed a stock company for the purpose of putting in an electric power house at his ranch. The Company will be known as the Alamogordo Consumers' Light & Power Company.

FORT BAYARD, N. M.—Sealed bids in triplicate for the electric light wiring and electric light fixtures for one double set of hospital sergeant's quarters and one power plant with machinery for a refrigerating and electric light system at this post will be received until February 15th.

TACOMA, WASH.—Sealed proposals will be received at the office of Public Works, to the 12th of January, for $25,000 worth of incandescent lamps, to be delivered f. o. b. Tacoma, Wash., to the city of Tacoma, within one year and in such quantities as may be ordered from time to time by the Commissioner of Public Works.

VICTORIA, B. C.—The city will co-operate with the property owners on Douglas street for the lighting of that thoroughfare from Humboldt to Cormorant streets by means of the usual system of arc lamps. Mr. Challoner asked that the City Council should join with the owners in endeavoring to get the B. C. Electric Company to do everything possible to assist in the work of improvement.

SAN BERNARDINO, CAL.—The Corona gas plant has been swallowed up by the gas combine headed by J. M. Gardener of Pasadena. This announcement was made by the general superintendent of the San Bernardino Valley Gas Co., which now dominates the gas situation in this county and Riverside, having taken over the gas plants here, at Redlands, Riverside and Colton. It is proposed to install a general distributing plant either here or at Colton, and under heavy pressure distribute gas throughout the wide territory involved.

CHICO, CAL.—When the City Trustees met last week to open bids for city lighting there was but one bid presented, that of the Pacific Gas & Electric Company, but there were representatives of two other concerns, and as a result the opening of bids was postponed for a week. F. P. Bergen, superintendent of the Sacramento Valley Power Company, appeared and asked the trustees to delay the opening of bids indefinitely in order to permit of his company submitting a bid. He stated that the company expected to be serving Chico by the middle of February or March 1.

TRANSORTATION.

PUYALLUP, WASH.—The Puget Sound Electric Railway has begun laying concrete between its tracks on Stewart street.

FRESNO, CAL.—The Fresno Traction Company is planning to begin the work of the reconstruction of its unfinished lines and also the double-tracking at Fresno.

VISALIA, CAL.—The Southern Pacific has agreed to build an electric road between Visalia and Tulare if the people along the way will grant the necessary right of way.

BRAWLEY, CAL.—W. F. Holt has completed arrangements to build the Holton Interurban westward from El Centro to New River, where a new town is to be started.

POMONA, CAL.—A grading crew of the Pacific Electric Company is working through Claremont and a second trolley wire on Garey avenue, from Holt avenue north is being placed.

SAN BERNARDINO, CAL.—Bids will be received by the Board of Supervisors up to January 24, 1910 for a franchise for an electric railway, according to the application of W. W. Poole.

SAN FRANCISCO, CAL.—It has been decided to move the general offices of the United Railroads of this city from their present location in the Balboa Building to the Wells-Fargo Building.

CLE ELUM, WASH.—The City Council has refused to grant a franchise to the Cle Elum-Roslyn electric line because the promoters of the company refused to inform the Council of their intentions.

MONTESANO, WASH.—A. D. Devonshire is asking an injunction against the Eldridge Wheeler franchise for an interurban road through this county granted by the commissioners some time ago.

ASTORIA, ORE.—It is learned on the authority of an official of the company that the Lytle road, which is now being built from Hillsboro to the ocean at Tillamook Bay, is to be operated by electricity as soon as it is completed.

CHIHUAHUA, MEX.—The Chapala Hydroelectric and Irrigation Company has purchased the electric street railways of Aguascalientes and will operate them. The purchaser is the company which proposes transmitting hydroelectric power from Chapala to Aguascalientes.

WALLA WALLA, WASH.—E. M. Symonds of this place announces that new surveys are being made and portions of the right of way secured for the proposed Spokane, Walla Walla & Western Tranction Company's electric road and that work will begin on the road within a short time.

NEW WESTMINSTER, B. C.—Provision for the expenditure of a half million dollars was made at a recent meeting of the heads of the British Columbia Electric Railway and other companies. A large part of the money will be expended in building car shops and the remainder in rolling stock.

WALLACE, IDAHO.—R. A. Wilson of this place said in an interview that the residents of this city and the Coeur d'Alenes in general will renew their campaign for the extension of the Spokane & Inland Empire Electric Railway system from Coeur d'Alene City to Wallace to give them direct connection with Spokane..

LOS ANGELES, CAL.—A franchise for an extension of the West Ninth street electric line from Ninth to Park View street to Harvard, has been sold by the Council for $100 to Fred Forrester, representing property owners who have raised a bonus of $12,000 to induce the Los Angeles Railway Company to build an extension.

LOS ANGELES, CAL.—At a meeting of the Boyle Evergreen Improvement Association the committee in charge of the movement to secure extension of the Brooklyn avenue electric line from Evergreen avenue east to the city limits reported that of the $30,000 which it was expected to collect from property owners only $14,000 has been collected, leaving a balance of $16,000 which must be raised.

OAKLAND, CAL.—Announcement is made simultaneously with the advent of a corps of engineers who commenced surveying Leise avenue, the main street in Allendale, yesterday afternoon, by officials of the Oakland Traction Company, that it will extend the Leise avenue car line from Penniman street, the present terminus, in a northeasterly direction to within one block of the new Laurel school, a distance of nearly one mile.

OAKLAND, CAL.—The Oakland and Antioch Electric Railway is at last assured, and work was begun on the grading of the new road yesterday. The section of the road first to be built will extend from Oakland to Walnut Creek and Bay Point, with a branch to Martinez. The second section, which will be built immediately afterward, will extend to Antioch. It is the intention of the promoters to extend the road eventually to Stockton, where it will connect with other lines throughout the interior of the State. A. W. Malthy and S. L. Naphthaly, property owners of the Concord and Walnut Creek district, and heavily interested in the Central California road, between Stockton, Lodi and Sacramento, are the promoters of the project.

SAN JOSE, CAL.—By February 1st it is probable electric cars will be in operation between San Jose and Palo Alto by way of Meridian Corners, Monte Vista, Los Altos and Mayfield. Last week an order from the Southern Pacific offices went into effect on the "cut-off" line from Mayfield to Los Gatos, whereby the steam trains will hereafter use only the east track of the double-track line between Mayfield and Congress Junction, the west track being turned over to the Peninsula Railway Company, which is now "bonding" the rails with electric wires, erecting poles and stringing trolley lines over the track mentioned, from Mayfield as far as Monte Vista, where the tracks of the "cut-off" intersect those of the Cupertino trolley line to San Jose. It is expected that the work will be completed before February 1st, and that by that date, electric trolley cars will be in operation over the system from Palo Alto through Mayfield, Los Altos, Monte Vista, Meridian Corners, and into San Jose.

SAN FRANCISCO, CAL.—Attorney H. D. Pillsbury filed a petition in the U. S. Circuit Court last week asking for permission to intervene in the receivership proceedings instituted by the Baldwin Locomotive Works against the Ocean Shore Railway Company, and an order was signed by Circuit Judge Morrow granting the intervention. Pillsbury states that to build a single track road of 52 miles and equip it with steam has cost approximately $7,000,000. To complete the gap with 26 miles of double track, to double track that already built, to equip with electricity, to secure terminal facilities and to pay up indebtedness of $1,800,000 are the labors confronting the receiver, and it is urged by Pillsbury that they cannot be accomplished with an issue of $3,500,000 of receiver's certificates. He asks that competent engineers, who have never had connection with the road, be appointed before receiver's certificates are issued, and that they make a report on the estimated cost of completing the road. If the certificates are authorized he asks that their use be limited by the court, and that all other means be used to preserve their integrity.

WATERWORKS.

HELENA, CAL.—The Sacramento Valley Sugar Company contemplates the installation of a 1000 h. p. electric pumping plant for irrigation purposes at Helena, Cal.

SAN LUIS OBISPO, CAL.—The franchise to lay and maintain water pipes along the county roads and through the town of Avila has been awarded to G. O. Marre.

BAKER CITY, ORE.—An election to decide whether the upper or lower pipe line shall be used will be held January 20th. Bonds will be issued to cover the cost of the project.

CHICO, CAL.—The laying of pipe for Paradise's new water system will begin soon. A shipment of 5000 feet of pipe from San Francisco is expected in a few days. A tower is to be erected and a pump established.

PHOENIX, ARIZ.—The Board of Control of Ariz., at its office in the Capitol Building here, will receive sealed bids up to January 20th for furnishing one 50,000 gallon steel tank on a 40-foot steel tower, erected complete and ready for use at the Territorial prison at Florence.

LOS ANGELES, CAL.—Sealed bids will be received at the office of Treasurer Pacific Branch N. H. D. V. S. Soldiers Home, until January 14th for furnishing and laying sheet steel pipe branches in Mandeville canyon, in accordance with instructions with E. W. Moore.

SALEM, ORE.—Engineer W. J. Culver was employed by the city to make a survey to the Breitenbush for a water supply and estimate the cost as follows: Cost of right of way, laying pipes and bringing water to Salem, $605,088; cost of equipment and site for works, dam, etc., $183,682.

TACOMA, WASH.—The City Council has adopted a resolution for the laying of water mains on portions of McKinley avenue, South Fortieth street, Division Lane, Columbia avenue, East E street, East F street, East G street, South Thirty-eighth street, the same in local improvement district No. 549.

TOWNSEND, WASH.—Diver Finch has reported that the submarine pipe line which conducts water from the Olympic gravity system to Fort Flagler, where it crosses Scow Bay, is in bad shape and will require considerable time and expense to place in serviceable condition. The only way to remedy the evil is to relay the pipe around the extreme head of the bay.

SAN FRANCISCO, CAL.—City Attorney Long has advised the Board of Public Works that the bid of $139,000 submitted on behalf of Hansbrough Bros. Co. for the erection of the new Townsend street pumping station of the auxiliary water supply system must be rejected as invalid, though the lowest offer, because of being signed simply "S. L. Hansbrough, secretary," instead of the official name of the corporation. The City Attorney's opinion is of moment to the Public Works Board, as that body has already ordered all the bids, including that of Hansbrough Bros., to be rejected, but has been served with a citation secured from the Superior Court summoning the board to show cause on December 30 why the rejected bid shall not be accepted, the company insisting that it is valid.

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JOURNAL OF ELECTRICITY
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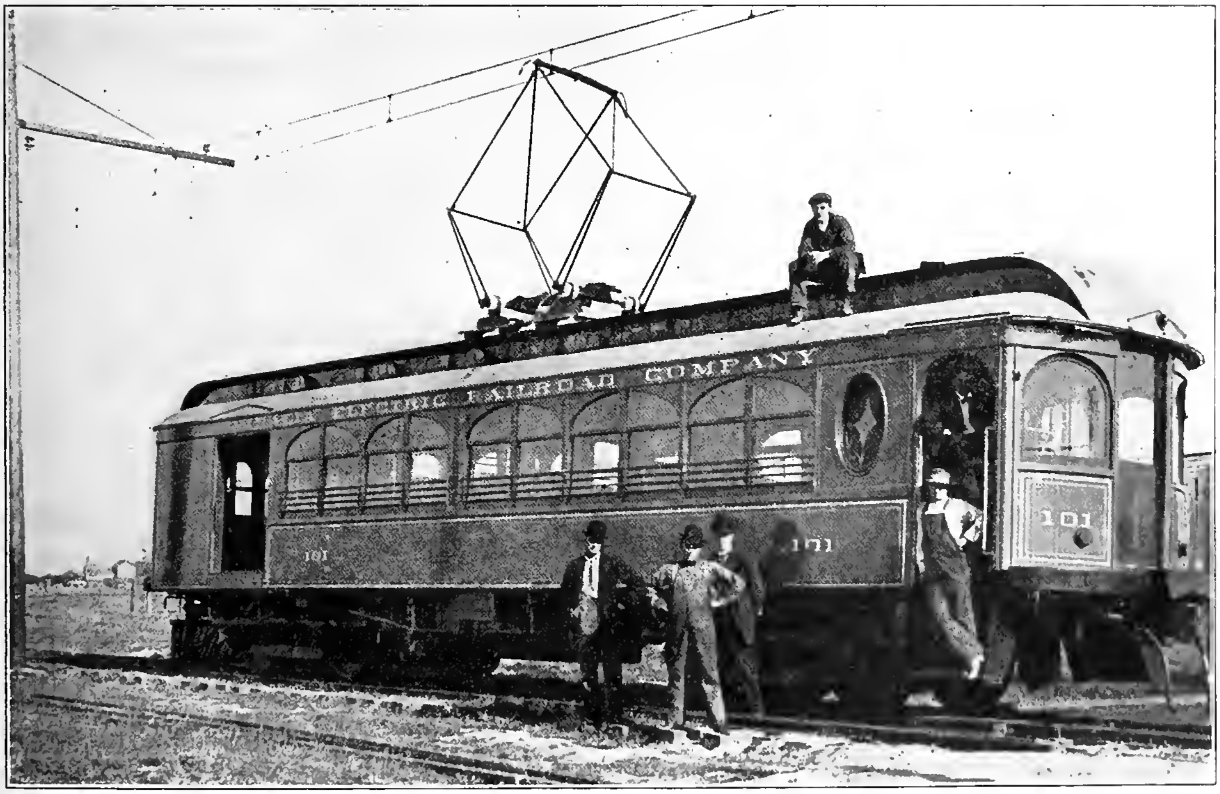
VOLUME XXIV — SAN FRANCISCO, JANUARY 15, 1910 — NUMBER 3

VISALIA FIFTEEN CYCLE SINGLE PHASE RAILWAY[1]

The first, and at the same time the only, 15 cycle, single phase, alternating current railway in the United States is the Visalia Electric Railroad, running from Visalia to Lemon Cove, California. After two years it will undoubtedly become an important link in the large electric railway system which seems destined to cover that section of the San Joaquin Valley at a date not far distant.



Single-Phase Interurban Electric Car on Visalia Railway.

of successful operation, this pioneer 15 cycle development has fully justified the confidence and courage of its builders in selecting, untried, a system of electrification without the restrictions for heavy main line service shown by the other systems investigated. Although the present length of electrical operation is only 22 miles, the location of the Visalia road is such that

For a distance of ten miles, between Visalia and Exeter, the electric railway traverses the main track of the Southern Pacific Railroad which has been electrified over this section by the addition of rail bonds, and the 3300 volt trolley. Twelve miles farther, from Exeter to Lemon Cove, a new road bed has been constructed, making the total length of the Visalia-Lemon Cove electrified route 22 miles. The road is single tracked throughout with the exception of the switching

[1]For further data see Journal of Electricity, Power and Gas, August 31, 1907.

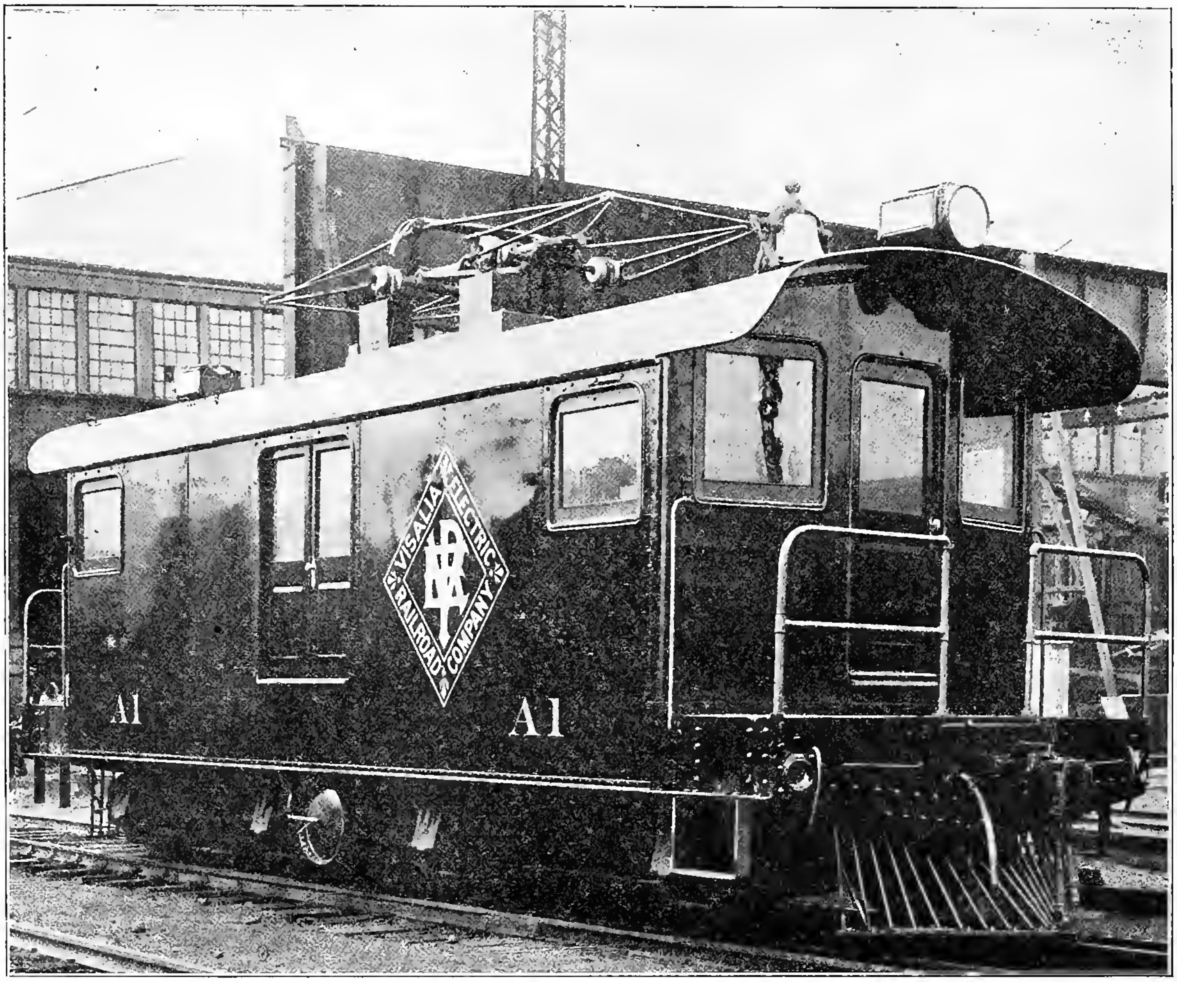
and freight yards at Visalia, Exeter and Lemon Cove. The trolley construction is of the single catenary type, suspended from brackets on poles spaced 120 feet apart.

Ground was broken for the Exeter and Lemon Cove extension in March, 1905, and the road was operated by steam locomotives in December, 1905. In March, 1908, the steam service was discontinued, and since that the road has been operated by electricity.

From Visalia to Exeter the country is practically level. Between Exeter and Lemon Cove the land is of a rolling nature, but the maximum gradient on the road has been kept down to 0.9 per cent. and the curves are of long radius. The worst conditions are met on a combined ten degree curve on a 0.9 per cent grade.

For this electrification, three-phase, 60 cycle power is purchased at 35,000 volts, from the Mt. Whitney Power Company, which operates a hydroelectric generating plant on the Kaweah River. At the Exeter substation, nearly at the center of the present railway line, the 60 cycle power is stepped down to 2200 volts, and then converted to 15 cycle, 11,000 volt, single-phase current by a Westinghouse synchronous motor generator set. From the main frequency changing substation at Exeter, the 15 cycle, 11,000 volt feeder lines, made up of a pair of No. 4 bare copper conductors, transmit eight miles in each direction to the substations on the Lemon Cove and Visalia divisions. Transformers in these stations reduce the 15 cycle, 11,000 volt, single phase supply to the trolley pressure, 3300 volts.

The frequency changer sub-station contains six 150 k. w. oil insulated, water cooled, 35,000 to 2200 volts, 60 cycle Westinghouse transformers, and two two-bearing motor generator sets, each composed of a 540 h. p. Westinghouse synchronous motor wound for 2200 volts, 60 cycles, with induction motor for starting; direct connected to a 375 k. w. rotating field, single phase Westinghouse alternator, delivering 11,000 volts, 60 cycle current. The 60 cycle incoming transmission line is protected by low equivalent lightning arresters, complete with oil insulated choke coils and disconnecting switches. Three 15 k. w., 2200 to 200 volts, 60 cycle transformers are supplied for lighting service and for operating the motor generator exciter set. On the extended shafts of each motor generator set are mounted 125 volt direct current generators which furnish excitation current, in addition to a similar direct current exciter driven by a three-phase 60 cycle induction motor supplied from the in-coming transmission lines. The out-going 11,000 volt, 15 cycle feeder circuits are protected against lightning discharges by



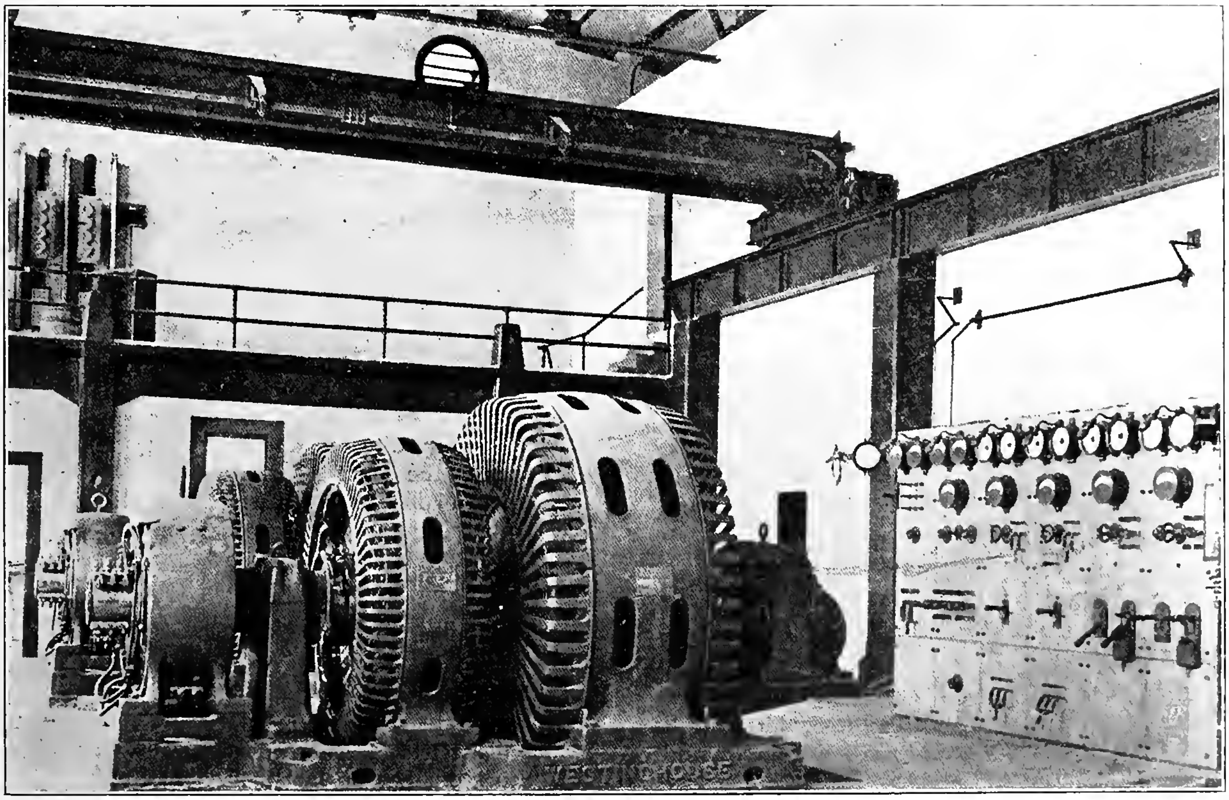
Westinghouse Fifteen-Cycle Single-Phase Electric Locomotive on Visalia Electric Railway.

complete arrester apparatus, and are controlled by oil switches. The Exeter sub-station also feeds the trolley wire through two 300 k. w., oil insulated, self-cooling, 15 cycle, single phase transformers, reducing from 11,000 to 3300 volts.

The two 15 cycle transforming sub-stations, each located about eight miles from Exeter in the direction of Lemon Cove and Visalia, respectively, contain a Westinghouse 300 k. w., oil insulated, water cooled, 15 cycle, single phase transformer, reducing from 11,000 volts to the trolley pressure. Lightning protective apparatus, choke coils, and high tension circuit breakers are included in the 11,000 volt apparatus, while the 3300 volt trolley feeders are controlled by oil circuit breakers.

The motor cars and locomotives are supplied with power through pantagraph trolleys, and carry auto-transformers arranged with taps for reducing the trolley pressure to voltages suitable for supplying the motors, car lighting, and air compressors. The motor cars have oil insulated, self-cooled auto-transformers, while that on the locomotive is air cooled from the motor driven blower equipment furnished for the forced ventilation of the motors.

The 45-ton electric locomotive is of the double swivel truck class, provided with car type of cab, and has the following general over-all dimensions: length over bumpers, 29 feet; extreme width, 9 feet 6 inches; height, rail to top of cab, 11 feet 7 inches; rigid wheel base, 7 feet 4 inches.



Interior of Exeter Frequency-Changing Sub-Station.

The 15 cycle 3300 volt, single phase trolley construction is of the single catenary bracket type, comprising a 7/16 inch steel messenger suspended from poles 120 feet apart, and supporting No. 000 trolley wire. The redwood poles, 36 feet long, are set six feet in concrete.

The rolling stock comprises a 47-ton Baldwin-Westinghouse electric locomotive, equipped with four 125 h. p. Westinghouse series compensated, single phase motors driving 36-inch wheels through a gear reduction of 17 to 66; four 40-ton passenger cars, each equipped with four 75 h. p. motors; two 28-ton trailer cars of construction similar to the above motor cars.

Cars and locomotives are all supplied with unit switch control, and automatic air brake equipment. The trailer cars as well as the motor cars are fitted with brake valves and master controllers so that three-car trains can be operated from a trailer car at the head of the train if desired.

With its four 125 h. p. motors connected to 36-inch wheels through a gear reduction of 66 to 17, this locomotive is capable of developing a continuous draw-bar pull of 4500 lbs. at 20 miles per hour on level track. The full-load draw-bar pull is 9000 lbs. at 17 miles per hour on the level. The maximum starting draw-bar pull is 17,000 pounds.

The capacity of each sub-station was designed to take care of the electric locomotive fully loaded, or one train of two motor cars and one trailer. In general service, only single motor cars are operated, without trailers, but when crowds are to be handled or the traffic conditions warrant, three-car trains are run. As an operating test, a six-car train has been successfully operated over the entire system.

The maximum regular operating speed is 45 miles per hour, although a single motor car has developed 62 miles per hour. The fast cars of the system run from Visalia to Exeter in 23 minutes, and from Exeter

to Lemon Cove in 21 minutes, calling for a schedule speed of 31 miles per hour.

A recent incident provides evidence of the ample tractive power of the locomotive. While doing some switching around the yard at Exeter, in order to get hold of a certain car, it was necessary for the electric locomotive to move a string of 40 standard refrigerator cars standing in the way. Twenty-eight of these were loaded, making the total weight of the train 1044 tons, which was handled and switched around the yards by the electric locomotive without special effort.

The following figures will afford the reader some idea of the economy with which this single phase, 15 cycle road is operating: During a period of 40 days over which readings were taken, the average power consumption of the locomotive was 72.4 watts per ton mile. During 60 days, the average output of the frequency changer sub-station was 70.25 watts per ton mile, although during another period of 30 days when operating conditions were better, the average station output was 66.6 watts per ton mile. During 60 days of operation of the motor cars, the actual power consumption at the car was found to be 55.9 watts per ton mile.

The electrical equipment of the Visalia 15 cycle, single phase electric railway, including locomotive, cars, and sub-station apparatus, was furnished by the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa.

MEETINGS OF THE AM. SOC. M. E.

Meetings of the American Society of Mechanical Engineers will be held in New York on January 11, in St. Louis on January 15, and in Boston on January 21. The spring meeting of the Society will be held this year as usual, in addition to the London meeting which occurs in July. Atlantic City has been selected as the place for the spring meeting and it will be held from May 31 to June 3 inclusive. The headquarters during the meeting will be at the Hotel Marlboro-Blenheim.

The January meeting in Boston will take the form of a banquet at the Hotel Somerset to be tendered jointly by the American Society of Mechanical Engineers, the Boston Society of Civil Engineers, and the Boston branch of the American Institute of Electrical Engineers, to the presidents of the three societies, George Westinghouse, George B. Francis and L. B. Stillwell, respectively, and other guests, including John Anderson Bensel, the incoming president of the American Society of Civil Engineers. Following the banquet there will be addresses by several of the guests and a paper will be presented on the main and auxiliary machinery of the battleship North Dakota, illustrated by lantern slides.

The president of the Boston Society of Civil Engineers will also outline what his Society has accomplished toward a project that has been under discussion at Boston for a united engineering building to be occupied by the several professional engineering organizations located in the city and vicinity.

The New York monthly meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies' Building on Tuesday evening, January 11. The subject for discussion is Lubrication. The paper upon Efficiency Tests of Lubricating Oils by Prof. F. H. Sibley of the University of Alabama, will be presented and important contributions upon the properties of lubricants, their efficiency, durability, characteristics, etc., will be made by Dr. C. F. Mabery of Case School, Cleveland, and General Charles Miller of Franklin, Pa.

Dr. Mabery has been engaged for a long period of time in experiments upon lubricating oils and has obtained results of unusual interest, because of the uniformity attained in repeating experiments, always a difficult matter in testing lubricants. General Miller has been so long identified with the subject of lubrication and has so large a fund of information as a result of this experience that his remarks will add greatly to the interest of the evening. There will be discussions also by F. R. Low, editor of Power; I. E. Moultrop, mechanical engineer of the Boston Edison Company; J. P. Sparrow, chief engineer of the New York Edison Company, and others.

The subject of lubrication is so important in its bearing upon the conservation of power and upon machinery of all kinds, especially since the introduction of recent new types, such as the steam turbine and automobile, that it is desirable to have authentic information easily available for the use of engineers.

THE CALIFORNIA STATE ASSOCIATION OF ELECTRICAL CONTRACTORS.

The California State Association of Electrical Contractors continues to grow in all parts of the State. A recent meeting of electrical contractors at Sacramento was attended by W. S. Hanbridge, president; L. R. Boynton, director, and F. V. Meyers, secretary-treasurer of the State Association. A thoroughly interesting and instructive session was had and almost every electrical contractor in Sacramento was added to the membership of the State Association, and steps taken preliminary to forming them without delay into a district local.

In Oakland the membership is increasing and in Los Angeles such energy has been displayed that practically every electrical contractor there and in that vicinity is now a member of the State Association and of the district local in that jurisdiction.

Stockton, Fresno, San Jose, Bakersfield and San Diego are contributing or will contribute in the very near future their proportionate share of members, and altogether everything is rapidly reaching a condition which will make the organization very influential to the interests of its members.

One of the subjects which will have attention all over the State will be the question of the betterment of the standard of electrical installation, and in this regard the influence of the association was potently felt recently in San Francisco when it procured the enactment of an ordinance by the Board of Supervisors of that city and county which requires all electrical installation for light or power service installed after the 20th day of February, 1910, to be encased in conduit.

In July, 1910, the first annual convention of the State Association will be held at San Francisco, Cal., and the determination exists to make it an event in the history of the electrical contracting business on the Pacific Coast, and beyond any doubt a very large, enthusiastic and beneficial meeting will result.

F. V. MEYERS.

WIRELESS TELEGRAPHY.

BY GUGLIELMO MARCONI, D. SC., LL. D.

(Concluded.)

With regard to the presumed obstacle of the curvature of the earth, I am of opinion that those who anticipated difficulties in consequence of the shape of our planet had not taken sufficient account of the particular effect of the earth connection to both transmitter and receiver, which earth connection introduced effects of conduction which were generally at that time overlooked.

Physicists seemed to consider for a long time that wireless telegraphy was solely dependent on the effects of free Hertzian radiation through space, and it was years before the probable effect of the conductivity of the earth between the stations was satisfactorily considered or discussed.

Lord Rayleigh, in referring to trans-Atlantic telegraphy stated in May, 1903, "The remarkable success of Marconi in signalling across the Atlantic suggests a more decided bending or diffraction of the waves round the pertuberant earth than had been expected, and it imparts a great interest to the theoretical problem.

Professor J. A. Fleming, in his book on "The Principles of Electric Wave Telegraphy," gives diagrams showing what is now believed to be the diagrammatic representation of the detachment of semi-loops of electric strain from a simple vertical wire. As will be seen, these waves do not propagate in the same manner as free radiation from a classical Hertzian oscillator, but glide along the surface of the earth.

Professor Fleming further states in the above-quoted work:

"The view we here take is that the ends of the semi-loops of electric force, which terminate perpendicularly on the earth, cannot move along unless there are movements of electrons in the earth corresponding to the wave-motions above it. From the point of view of the elecronic theory of electricity, every line of electric force in the ether must be either a closed line or its ends must terminate on electrons of opposite sign. If the end of a line of strain abuts on the earth and move, there must be atom-to-atom exchange of electrons, or movements of electrons in it. We have many reasons for concluding that the substances we call conductors are those in which free movements of electrons take place. Hence the movements of the semi-loops of electric force outwards from an earthed oscillator or Marconi aerial is hindered by bad conductivity on the surface of the earth and facilitated over the surface of a fairly good electrolyte, such as sea-water."

Professor Zenneck has carefully examined the effect of earthed transmitting and receiving aerials, and has endeavored to show mathematically that when the lines of electrical force, constituting a wave front, pass along a surface of low specific inductive capacity, such as the earth, they become inclined forward, their lower ends being retarded by the resistance of the conductor to which they are attached.

It therefore seems well established that wireless telegraphy, as practiced at the present day, is dependent for its operation over long distances on the conductivity of the earth, and that the difference in conductivity between the surface of the sea and land is sufficient to explain the increased distance obtainable with the same amount of energy in communicating over sea as compared to over land.

I carried out some tests between a short station and a ship at Poole, in England, in 1902, for the purpose of obtaining some data on this point, and I noticed that at equal distances a perceptible diminution in the energy of the received waves always occurred when the ship was in such a position as to allow a spit of sand about one kilometer broad to intervene between it and the land station.

In January, 1901, some successful experiments were carried out between two points on the south coast of England, 186 miles apart, i. e., St. Catherine's Point (Isle of Wight) and The Lizard, in Cornwall. The total height of these stations above sea level did not exceed 100 meters, whereas to clear the curvature of the earth a height of more than 1600 meters at each end would have been necessary. The results obtained from these tests, which at the time constituted a record distance, seemed to indicate that electric waves produced in the manner I had adopted would most probably be able to make their way round the curvature of the earth, and that, therefore, even at great distances, such as those dividing America from Europe, the factor of the earth's curvature would not constitute an insurmountable barrier to the extension of telegraphy through space.

The belief that the curvature of the earth would not stop the propagation of the waves, and the success obtained by syntonic methods in preventing mutual interference, led me in 1900 to decide to attempt the experiment of testing whether or not it would be possible to detect electric waves over a distance of 4000 kilometers, which, if successful, would immediately prove the possibility of telegraphing without wires between Europe and America.

The experiment was, in my opinion, of great importance from a scientific point of view, and I was convinced that the discovery of the possibility to transmit electric waves across the Atlantic Ocean, and the exact knowledge of the real conditions under which telegraphy over such distances could be carried out, would do much to improve our understanding of the phenomena connected with wireless transmission. The transmitter erected at Poldhu, on the coast of Cornwall, was similar in principle to the one I have already referred to, but on a very much larger scale than anything previously attempted. The power of the generating plant was about 25 k. w.

Numerous difficulties were encountered in producing and controlling for the first time electrical oscillations of such power. In much of the work I obtained valuable assistance from Professor J. A. Fleming, Mr. R. N. Vyvyan and Mr. W. S. Entwistle.

My previous tests had convinced me that when endeavoring to extend the distance of communication, it was not merely sufficient to augment the power of the electrical energy of the sender, but that it was also necessary to increase the area or height of the transmitting and receiving elevated conductors.

As it would have been too expensive to employ

vertical wires of great height, I decided to increase their number and capacity, which seemed likely to make possible the efficient utilization of large amounts of energy.

The arrangement of transmitting antennae, which was used at Poldhu, consisted of a fan-like arrangement of wires supported by an insulated stay between masts only 48 meters high and 60 meters apart. These wires converged together at the lower end, and were connected to the transmitting apparatus contained in a building. For the purpose of the test a powerful station had been erected at Cape Cod, near New York, but the completion of the arrangements at that station were delayed in consequence of a storm which destroyed the masts and antennae.

I, therefore, decided to try the experiments by means of a temporary receiving station erected in Newfoundland, to which country I proceeded with two assistants about the end of November, 1901.

The tests were commenced early in December, 1901, and on the 12th of that month the signals transmitted from England were clearly and distinctly received at the temporary station at St. John's in Newfoundland.

Confirmatory tests were carried out in February, 1902, between Poldhu and a receiving station on the steamship Philadelphia of the American Line. On board this ship readable messages were received by means of a recording instrument up to a distance of 1551 miles, and test letters as far as 2099 miles from Poldhu. The tape records obtained on the Philadelphia at the various distances were exceedingly clear and distinct, as can be seen by the specimens exhibited.

These results, although achieved with imperfect apparatus, were sufficient to convince me and my co-workers that by means of permanent stations and the employment of sufficient power it would be possible to transmit messages across the Atlantic Ocean in the same way as they were sent over much shorter distances. The tests could not be continued in Newfoundland owing to the hostility of a cable company, which claimed all rights for telegraphy, whether wireless or otherwise, in that colony.

A result of scientific interest which I first noticed during the tests on the steamship Philadelphia, and which is a most important factor in long-distance radio-telegraphy, was the very marked and detrimental effect of daylight on the propagation of electric waves at great distances; the range by night being usually more than double that attainable during daytime.

I do not think that this effect has yet been satisfactorily investigated or explained. At the time I carried out the tests I was of opinion that it might be due to the loss of energy at the transmitter, caused by the dis-electrification of the highly-charged transmitting elevated conductor under the influence of sunlight.

I am now inclined to believe that the absorption of electric waves during the daytime is due to the ionization of the gaseous molecules of the air affected by ultra-violet light, and as the ultra-violet rays, which emanate from the sun, are largely absorbed in the upper atmosphere of the earth, it is probable that the portion of the earth's atmosphere which is facing the sun will contain more ions or electrons than that portion which is in darkness, and, therefore, as Sir J. J. Thomson has shown, this illuminated and ionized air will absorb some of the energy of the electric waves.

Apparently the length of wave and amplitude of electrical oscillations have much to do with this interesting phenomenon, long waves and small amplitudes being subject to the effect of daylight to a much lesser degree than short waves and large amplitudes.

According to Professor Fleming, the daylight effect should be more marked on long waves, but this has not been my experience. Indeed, in some very recent experiments in which waves about 8000 meters long were used, the energy received by day was usually greater than at night.

The fact remains, however, that for comparatively short waves, such as are used for ship communication, clear sunlight and blue skies, though transparent to light, act as a kind of fog to these waves. Hence the weather conditions prevailing in England, and perhaps in this country, are usually suitable for wireless telegraphy.

During the year 1902 I carried out some further tests between the station at Poldhu and a receiving installation erected on the Italian cruiser Carlo Alberto, kindly placed at my disposal by H. H. the King of Italy. During these experiments the interesting fact was observed that, even when using waves as short as 1000 ft., intervening ranges of mountains, such as the Alps or Pyrenees, did not, during the night time, bring about any considerable reduction in the distance over which it was possible to communicate. During daytime, unless much longer waves and more power were used, intervening mountains greatly reduced the apparent range of the transmitter.

Messages and press dispatches of considerable length were received from Poldhu at the positions marked on the map, whch map is a copy on a reduced scale of the one accompanying the official report of the experiments.

With the active encouragement and financial assistance of the Canadian Government, a high power station was constructed at Glace Bay, Nova Scotia, in order that I should be able to continue my long-distance tests, with a view to establishing radio-telegraphic communication on a commercial basis between England and America.

On December 16, 1902, the first official messages were exchanged at night across the Atlantic, between the stations at Poldhu and Glace Bay.

Further tests were shortly afterwards carried out with another long-distance station at Cape Cod, in the United States of America; and under favorable circumstances it was found possible to transmit messages to Poldhu, 3000 miles away, with an expenditure of electrical energy of only about 10 k. w.

In the spring of 1903 the transmission of press messages by radio-telegraphy from America to Europe was attempted, and for a time the London Times published, during the latter part of March and the early part of April of that year, news messages from its New York correspondent, sent across the Atlantic without the aid of cables.

A breakdown in the insulation of the apparatus at Glace Bay made it necessary, however, to suspend the service, and, unfortunately, further accidents made the transmission of messages uncertain and unreliable.

As a result of the data and experience gained by these and other tests, which I carried out for the British Government, between England and Gibraltar, I was able to erect a new station at Clifden in Ireland, and enlarge the one at Glace Bay in Canada, so as to enable me to initiate, in October, 1907, communication for commercial purposes across the Atlantic between England and Canada.

Although the stations at Clifden and Glace Bay had to be put into operation before they were altogether complete, nevertheless communication across the Atlantic by radio-telegraphy never suffered any serious interruption during nearly two years, until, in consequence of a fire at Glace Bay this autumn, it has had to be suspended for three or four months.

This suspension has not, however, been altogether an unmitigated evil, as it has given me the opportunity of installing more efficient and up-to-date machinery. The aerial used consisted of a nearly vertical portion in the middle, 220 ft. high, supported by four towers, and attached at the top to nearly horizontal wires, 200 in number and each 1000 ft. long, extending radially all round, and supported at a height of 180 ft. from the ground by an inner circle of 8 and an outer circle of 16 masts. The natural period of oscillation of this aerial system gave a wave-length of 12,000 ft. Experiments were made with this arrangement in 1905; and with a wave-length of 12,000 ft., signals, although very weak, could be received across the Atlantic by day as well as by night.

The system of aerial I finally adopted for the long-distance stations in England and Canada not only makes it possible to efficiently radiate and receive waves of any desired length, but it also tends to confine the main portion of the radiation to a given direction. The limitation of transmission to one direction is not very sharply defined, but the results obtained with this type of aerial are nevertheless exceedingly useful.

Many suggestions respecting methods for limiting the direction of radiation have been made by various workers, notably by Professor F. Braun, Professor Artom and Messrs. Bellini and Tosi.

In a paper read before the Royal Society in London in March, 1906, I showed how it was possible by means of horizontal aerials to confine the emitted radiations mainly to the direction of their vertical plane, pointing away from their earthed end. In a similar manner it is possible to locate the bearing or direction of a sending station. The transmitting circuits at the long-distance stations are arranged in accordance with a comparatively recent system for producing continuous or slightly damped oscillations, which I referred to in a lecture before the Royal Institution of Great Britain on March 13, 1908.

An insulated metal disc A is caused to rotate at a high rate of speed by means of an electric motor or steam turbine. Adjacent to this disc, which I will call the middle disc, are placed two other discs (C′ and C″), which may be called polar discs, and which are also revolved. These polar discs have their peripheries very close to the surface or edges of the middle disc. The two polar discs are connected by rubbing contacts to the outer ends of two condensers K, joined in series, and these condensers are also connected through suitable brushes to the terminals of a generator, which should be a high tension continuous current generator.

On the middle dics a suitable brush or rubbing contact is provided, and between this contact and the middle point of the two condensers an oscillating circuit is inserted, consisting of a condenser E in series with an inductance, which last is inductively connected with the radiating antennae. The apparatus works probably in the following manner: The generator charges the double condenser, making the potential of the discs, say C′ positive and C″ negative. The potential, if high enough, will cause a discharge to pass across one of the gaps, say, between C′ and A. This charges the condenser E through the inductance F, and starts oscillations in the circuit. The charge of F in swinging back will jump from A to C″, the potential of which is of opposite sign to A, the dielectric strength between C′ and A having meanwhile been restored by the rapid motion of the disc, driving away the ionized air. The condenser E, therefore, discharges and recharges alternately in reverse directions, the same process going on so long as energy is supplied to the condensers K by the generator H. It is clear that the discharges between C′ and C″ and A are never simultaneous, as otherwise the center electrode would not be alternatively positive and negative.

The best results have, however, been obtained by an arrangement in which the active surface of the middle disc is not smooth, but consists of a number of regularly spaced copper knobs or pegs, at the ends of which the discharges take place at regular intervals.

In this way it is possible to cause the groups of oscillations radiated to reproduce a high and clear musical note in a receiver, and thereby it is easier to differentiate between the signals emanating from the sending station and noises caused by atmospheric electrical discharges. By this method very efficient resonance can be also obtained in appropriately designed receivers.

With regard to the receivers employed, important changes have taken place. By far the larger portion of electric wave telegraphy was, until a few years ago, conducted by means of some form or other of coherer, or variable contact either requiring tapping or else self-restoring.

At the present day, however, I may say that at all the stations controlled by my company, my magnetic receiver is almost exclusively employed. This receiver is based on the decrease of magnetic hysteresis, which occurs in iron when under certain conditions this metal is subjected to the effects of electrical waves of high frequency. It has recently been found possible to increase the sensitiveness of these receivers, and to employ them in connection with a high speed relay, so as to record messages at great speed.

A remarkable fact, not generally known, in regard to transmitters is, that none of the arrangements employing condensers exceed in efficiency the plain, elevated aerial or vertical wire discharging to earth

through a spark gap, as used in my first experiments.

I have recently been able to confirm the statement made by Professor Fleming in his book, "The Principles of Electric Wave Telegraphy" (1906, page 555), that with a power of 8 watts in the aerial it is possible to communicate to distances of over 100 miles.

I have also found that by this method it is possible to send signals 2000 miles across the Atlantic, with a smaller expenditure of energy than by any other method known to myself.

The only drawback to this arrangement is, that unless very large aerials are used, the amount of energy which can be efficiently employed is limited by the potential beyond which brush discharges and the resistances of the spark gap begin to have a deleterious effect.

By means of spark gaps in compressed air, and the addition of inductance coils placed between the aerial and earth, the system can be made to radiate very pure and slightly damped waves, eminently suitable for sharp tuning.

In regard to the general working of wireless telegraphy, the widespread application of the system and the multiplicity of the stations have greatly facilitated the observation of facts not easily explainable.

Thus it has been observed that an ordinary ship station utilizing about half a kilowatt of electrical energy, the normal range of which is not greater than 200 miles, will occasionally transmit messages across a distance of over 1200 miles. It often occurs that a ship fails to communicate with a nearby station, but can correspond with perfect ease with a distant one.

On many occasions last winter the steamship Caronia of the Cunard Line, carrying a station utilizing about half a kilowatt, when in the Mediterranean, off the coast of Sicily, failed to obtain communication with the Italian stations, but had no difficulty whatsoever in transmitting and receiving messages to and from the coasts of England and Holland, although these latter stations were considerably more than 1000 miles away, and a large part of the continent of Europe and the Alps lay between them and the ship.

Although high-power stations are now used for communicating across the Atlantic, and messages can be sent by day as well as by night, there still exist short periods of daily occurrence, during which transmission from England to America, or vice versa, is difficult. Thus in the morning and evening, when in consequence of the difference in longitude, daylight or darkness extends only part of the way across the ocean, the received signals are weak and sometimes cease altogether. It would almost appear as if electric waves in passing from dark space to illuminated space, and vice versa, were reflected in such a manner as to be diverted from their normal path.

It is probable that these difficulties would not be experienced in telegraphing over equal distances north and south, on about the same meridian, as in this case the passage from daylight to darkness would occur almost simultaneously over the whole distance between the two points.

Another curious result, on which hundreds of observations continued for years leave no further doubt, is that regularly, for short periods, at sunrise and sunset, and occasionally at other times, a shorter wave can be detected across the Atlantic in preference to the longer wave normally employed.

Thus at Clifden and Glace Bay, when sending on an ordinary coupled circuit arranged so as to simultaneously radiate two waves, one 12,500 ft. and the other 14,700 ft., although the longer wave is the one usually received at the other side of the ocean, regularly, about three hours after sunset at Clifden, and three hours before sunrise at Glace Bay, the shorter wave alone was received with remarkable strength, for a period of about one hour. This effect occurred so regularly that the operators tunded their receivers to the shorter wave at the times mentioned, as a matter of ordinary routine. With regard to the utility of wireless telegraphy there is no doubt that its use has become a necessity for the safety of shipping, all the principal liners and warships being already equipped, its extension to less important ships being only a matter of time, in view of the assistance it has provided in cases of danger.

Its application is also increasing as a means of communicating between outlying islands, and also for the ordinary purposes of telegraphic communication between villages and towns, especially in the colonies and in newly developed countries.

However great may be the importance of wireless telegraphy to ships and shipping, I believe it is destined to an equal position of importance in furnishing efficient and economical communication between distant parts of the world, and in connecting European countries with their colonies and with America. As a matter of fact, I am at the present time erecting a very large power station for the Italian Government at Coltano, for the purpose of communicating with the Italian colonies in East Africa, and with South America.

Whatever may be its present shortcomings and defects, there can be no doubt that wireless telegraphy, even over great distances, has come to stay, and will not only stay, but continue to advance.

If it should become possible to transmit waves right round the world, it may be found that the electrical energy traveling round all parts of the globe may be made to concentrate at the antipodes of the sending station. In this way it may some day be possible for messages to be sent to such distant lands by means of a very small amount of electrical energy, and, therefore, at a correspondingly small expense.

But I am leaving the regions of fact, and entering the regions of speculation, which, however, with the knowledge we have gradually gained on the subject, promise results both useful and instructive.

Examination for engineer in wood preservation is announced by the United States Civil Service Commission on January 19, 1910, to fill two vacancies in the position of engineer in wood preservation, one at $1,000 and the other at $1,300 per annum, Forest Service, for duty in District No. 2, with headquarters at Denver, Colorado, and vacancies requiring similar qualifications as they may occur.

STANDARDIZATION RULES OF THE A.I.E.E.[1]

BY DR. C. P. STEINMETZ.

The subject on which I desire to speak is the Standardization Rules of the American Institute of Electrical Engineers. My reason for selecting this subject is that, in my experience, these standardization rules are not as well known to many engineers as their importance makes it desirable. In my opinion, the Standardization Rules represent the most important work the American Institute of Electrical Engineers has ever undertaken, and constitute one of the most important documents in the literature of the electrical engineering industry, for I believe that the rapid and successful advance of the electrical industry of the United States is to no small extent due to their existence.

At present few of us realize the conditions which existed before these rules were drawn up and generally adopted. These rules have made it possible to build good apparatus and sell good apparatus, which procedure was not always possible before that time. The standard set by the rules is high, but not too high. It can easily be attained, and yet it is sufficiently high to be safe, though no more. Since their adoption, the rating of any piece of electrical apparatus whatever means something definite, and means the same thing within the limits of the relative conscientiousness of the different manufacturers, no matter from what manufacturer it may be bought; and these limits are very narrow, because the tests are specified and may be easily made to check up the required performance, thus making it impossible to deviate much from the standard without having it noticed. Now that has not always been the case. On the contrary, in the early days, a small manufacturer would make high guarantees regarding the efficiency and performance of his apparatus, which an engineer, knowing all about the apparatus, could not make. It will be realized that it was a very severe handicap to the advance of the electrical industry that those engineers who knew as much about the apparatus as was known at that time, were not able to build as good apparatus as possible because it could not be sold in competition with inferior apparatus which was guaranteed to have higher efficiencies. For instance, in those times core loss was a quantity not generally known. Quite commonly small manufacturers guaranteed efficiencies without figuring the core loss. It can be realized that a larger manufacturing company, having engineers who understood and could calculate this, might have built apparatus with much lower core loss and much higher efficiency, and still could not guarantee as high an efficiency as the manufacturer who did not take it into consideration. They knew of losses which others did not and which others therefore did not consider. At that time the commutator losses had just begun to be found out, but often the manufacturer did not dare include them in the losses because nobody else did, although they amounted to several per cent. It was a very unfortunate condition of affairs which made it necessary for those designing engineers who knew of the losses in the apparatus to count them in, while the engineers who were ignorant of their existence were able to sell inferior apparatus under higher guarantees; for the happy custom used to count only those losses which were specified, and of course the less specified the less the losses appeared. That condition of affairs has passed, and now the higher class of producers find it desirable to have everything known; to have tests of the performance and calculation of efficiency made, and the customer to know what the efficiency is, because they can gain by it. The same advantages accrue to the customer. He was formerly helpless when in the market to buy electrical apparatus, as one manufacturer guaranteed his apparatus at 92 per cent efficiency while another and smaller manufacturer was willing to sell him the same kind of apparatus cheaper and guaranteed at 95 per cent efficiency. What could the customer know and do? That condition is not possible now, for the manufacturer could not guarantee efficiencies not in existence—he would be found out. In 1892, when I wrote a paper on hysteresis losses, I remember that one engineer even claimed there was no such thing. It could not be, because the efficiency was known. There could not be such a loss, because it would have shown up in the efficiency and it would have been noticed. All that has now become generally known and understood, and this fact is to a very large extent due to the educational work done by these standardization rules.

The benefit resulting from these rules extends throughout the entire field of electrical work. In those early days, it must be realized that it was not generally accepted and recognized that the efficiency could be got by adding the losses. Commonly the engineers or customers rejected an efficiency test made in this manner. The recognition of the correctness of the method of measuring efficiency by adding the losses has from the first been brought out in those Standardization Rules. I recall an instance where some big machines were built and the question was, how to measure their efficiency. The input and output could not be measured very well on a 400 k. w. machine, which, in those days, was a monstrous machine. It was agreed that the core loss was one of the losses which was to be added. The customer insisted that it be taken at no load and full load excitation. The machine was one of those early high frequency alternators, and when run light at full load excitation gave 40 or 50 per cent higher voltage and two or three times the actual core loss obtained at full load. It took a long time to satisfy the customer that the addition of the losses gave the correct efficiency. Ultimately, however, the machines were accepted. When these machines went to England and were turned over to the customer, he would not accept them without further test; so they were coupled together, one being used as a motor and the other as a generator, and a whole series of tests were made, measuring the power input and output, and the input at all possible displacements, etc., to satisfy him that the efficiency was right. He finally accepted those tests, although I do not believe they meant anything; but he got what he wanted.

We know now what the efficiency is, what the losses are, and how the efficiency should be determined. Some consulting engineers had the habit of drawing up the most wonderful specifications, often 65 pages or more, specifying everything covering the armature,

[1]Lecture before Schenectady Section A. I. E. E., Nov. 2, 1909.

conductors and many other things. This was entirely improper, because that was no business of the customer—what he looks for is the performance. Even prominent consulting engineers frequently specified things of decided disadvantage and made it impossible to get the best machines for their purpose; for, while desiring to get the best apparatus, they made the mistake of specifying things which would be a disadvantage, as they were not familiar with the state of the art at that time. The early days of the industry are full of such instances.

Even though an agreement was reached, nothing definite was understood—it meant a different thing to different people. Speaking of the regulation of a machine: what did it mean? The Westinghouse Company understood something entirely different when guaranteeing regulation from what the Stanley Company or General Electric Company did. The one understood the percentage rise of excitation from no load to full load, and the other, the percentage increase of voltage at full load excitation when full load is thrown off. Such disagreements naturally made matters very difficult for a customer desiring to get apparatus, for the regulation would be guaranteed by one manufacturer as 8 per cent and by another as 12 per cent. Twelve per cent might have been a better regulation than 8 per cent because the latter might mean that if load is thrown off at full load, the voltage will not rise more than 8 per cent, and the other, if a change is made from no load to full load, a full excitation of 12 per cent increase was necessary.

Before people could understand each other and before customers could compare intelligently the offerings of different manufacturers, it became necessary to have some definite meaning for the different terms. People might use the same term and mean very different things.

The radical advance in the industry became possible only when all these children's diseases—the competition of manufacturers of inferior apparatus guaranteeing superior results by reason of lack of knowledge, etc.,—became eliminated, and all manufacturers and customers could meet on a common footing, employing the same terms and having to come up to the same performance. So in those early days the question of standardization was really of the greatest importance to customers, operating engineers, and to the manufacturers; and it was natural that the question of establishing standard rules should be brought before the Institute. That this was done is due to Mr. S. D. Greene, who is still a member of the organization. Mr. Greene read a paper before the American Institute of Electrical Engineers, drawing attention to the necessity of deciding what represented the best standards, the best practice, and the best definitions in the field of electrical engineering, as far as the prominent engineers could agree on the subject. As a result, the motion was made and finally carried to establish such standardization rules, and a committee was appointed to draw them up. Naturally, there was considerable discussion as to whether such rules would not handicap the development of the industry; they might hinder it, because of limitations, or they might sap inventive activity by establishing standards. Experience has shown that this has not been so. The rules have been very helpful in assisting development, have made unnecessary an enormous amount of waste effort, have combated foolish ideas by educating people to understand the meaning of terms, and have cleared up mistakes of understanding and made it possible for the results of the work to be recognized. If machinery and apparatus is superior it can be shown, which advantage was not always possible before. It is amusing now to remember some of those discussions. For instance, a motion was made that engineers connected with manufacturing companies should not be included in this Standardization Committee because of the fear that they might make the standard of the rules so low that it would be easy to build apparatus. As a matter of fact, most of the work on the rules as they stand has been done by Mr. C. F. Scott, of the Westinghouse Company, and by myself, both representing manufacturing companies which have always insisted on strictness and rigidity, and on making the requirements as high as could well be made, firmly resisting any attempt to reduce them. This is natural, because it can easily be seen that the manufacturer has no objection to building better machinery—it is really an advantage, because the better machinery will give a better record and not as much trouble; while if a cheap and poor machine is built the manufacturer gets the blame for it, and justly.

The standardization rules are of great advantage to the producer, to the designing engineer, and to the customer. They were started by a committee appointed by the A.I.E.E. and since then a committee for this work has been appointed every year. Every few years it becomes necessary to bring the rules up to standard and to add whatever new features have been developed in new industries that require attention.

Standardization rules have been drawn up and an attempt made to follow them in other countries, but in no country, as far as I know, have they been so generally accepted and so helpful to the industry as here in the United States. To a very large extent this is due to the close co-operation of the manufacturers, operating engineers, and theoretical men here; but in other countries the tendency is to delegate it to the theoretical men, who draw up rules from mere theoretical knowledge, which no manufacturer or customer can follow or cares to follow, and therefore such standardization rules have occasionally been handicaps.

It is natural that manufacturers' engineers should have done most of the work in drawing up the rules, because the engineer who designs the machine, and afterwards follows it in test and is held responsible by the Commercial Department for its successful operation, naturally knows the ins and outs of the machine better than can anyone else. He therefore knows better to what extent strict specifications should be made in order to get the best machine; and for him it is an advantage to see that specifications are high enough, so that he may not be held responsible for troubles that develop in his production outside.

The reason that the Standardization Rules have been so successful is that, from the beginning, the principle has been very rigidly maintained that the performance should be specified and not the design

data. For instance, in an armature winding, it is proper to specify the temperature, but it would be improper to specify current density. Any specifications or standards of design data are a handicap to the development of the industry, but the stanardization of performance has put a premium on designs which will make it possible to produce the same performance with a less amount of material and smaller apparatus, thus making the apparatus cheaper to manufacture.

Another mistake which has been carefully avoided, and which has been made especially by our European friends, is the attempt to specify size, speeds, etc. Such specifications tend to stop the advance of the art.

As I have already stated, the result has been accomplished by the co-operation of all representatives of the electrical industries in the country, and therefore the rules have not met with much difficulty in finding general acceptance.

We now come to a more specific discussion of some of the leading features of the Standardization Rules:

Classification of Apparatus. Classifying apparatus as motors and generators was entirely unsuitable. If it is desired to classify and draw up rules for measuring efficiency and specify what performance should be expected from motors, it is evident that synchronous motors, direct current shunt motors, induction motors and railway motors cannot be put in the same group. They are entirely different types of apparatus. Neither can synchronous generators, direct current commutating generators, and induction generators be put in the same group. Again, a direct current generator and direct current motor are practically the same machine. A direct current motor can be run as a generator, and inversely, a direct current generator can be run as a motor. A synchronous motor and an alternating current generator are the same class and type of machine, and the specifications for the performance of each would be the same. There may be some quantitative differences of a minor nature, as for instance, if a synchronous machine is designed to operate only as a motor, a higher armature reactance is chosen than if the machine is designed to operate only as a generator. We also have compound motors and shunt generators, and a definite line cannot be drawn between generators and motors; but there is a distinct dividing line between commutating machines and synchronous machines and between induction motors and synchronous motors. In many cases machines are installed where it is impossible to say whether they are generators or motors. Today they may be running as synchronous motors and tomorrow as generators. It is common in steam stations or water power plants to install synchronous motors to receive power from the transmission line and drive other apparatus, such as commutating machines for railway work, etc. During a period of low water it may not be possible to get power enough from the water and the synchronous motor has to be started as an alternating current generator. That is a very common thing. It became necessary to find a classification of electrical apparatus based on its nature, structure, and construction, and not on the particular use to which it happens to be put.

As an illustration of the confusion which existed in nomenclature of electrical apparatus before these rules were generally accepted, I mention the converter and transformer. It just happened that when the Westinghouse Company started to build alternating current transformers they called them converters. When the Thomson-Houston Company, the predecessor of the General Electric Company, started to build transformers, they called them transformers; so the same type of apparatus went by the name of converter in the Westinghouse Company and transformer in the General Electric Company. A synchronous converter was developed by the Westinghouse Company which they called a rotary transformer, because the stationary apparatus was called a converter; and the General Electric Company, which has used the name transformer for stationary apparatus, naturally called the other a rotary converter. This is one illustration of the different definitions which were applied to the same things. The Standardization Rules adopted what appeared to be the best practice, and in this case adopted the name transformer because it had come into general use by other people. Rules were drawn up to establish as definitions those terms which appeared to the committee as representing the best practice and were most generally accepted. Then we find definitions of quantities like load factor, saturation factor, pulsation, etc., which had to be standardized so as to mean something definite.

With the advance of the art, this work has been expanded and new chapters inserted. The procedure which has been followed is never to standardize anything until best practice has already crystalized upon some definite form, and not to create definitions, but accept those definitions toward which good practice tends and which therefore can easily be accepted. It is no longer the definition of a competitive company, but a definition of the Institute, an impartial body. A company may hesitate to change the name of its apparatus and adopt the name used by a competitor, but there can be no hesitation to adopt the name given to it by the general body of the Institute; and this tends to uniformity, which is not only desirable but absolutely necessary.

Then comes the second part of the rules, covering specifications of performance of apparatus, and tests; that is, how the apparatus should perform and how this performance should be determined by test. It can be readily appreciated that one of the most important considerations is efficiency—the definition and determination of efficiency—and one of the most important features of the work done by the rules is the establishment of a method of measuring efficiency by adding the losses, making that method safe by carefully scrutinizing the losses and showing how they should be measured. These efficiency specifications and the method of making tests are well worth careful study, because they are really the general standard for testing electrical apparatus.

In the matter of insulation, which is an important one, attention is directed to the importance of high voltage tests and the relative unimportance of measuring the ohmic resistance of insulation. The ohmic resistance of the insulation is increased by baking, and in this way one could get 50 megohms or more; but

this is liable to weaken the dielectric strength of the insulation. Tests of ohmic resistance are desirable as merely showing that there is no great leakage, but they do not show how the insulation will perform, which performance is given by the dielectric test. A standard of one minute has been established for tests for dielectric strength. It is unsafe and objectionable to extend the time of test much longer, because of harm to the insulation. High voltage tests must be made at voltages very much higher than those to which the insulation will be normally subjected, and such high voltage puts a strain on the insulation which deteriorates it. Therefore, the test should not be continued longer than necessary to make sure that the voltage is there, and one minute is sufficiently long for this purpose. With some kinds of apparatus, however, a half hour is specified. With some apparatus half an hour is not so bad, although a minute is better. Naturally when saying a minute is better, the same test is intended to be applied. One minute at 25,000 volts is preferable to half an hour at 10,000 volts. The shorter the time the voltage is kept on, with correspondingly higher voltage used to get the same severity, the less will be the deterioration of the insulation. Apparatus must be tested with at least twice its rated voltage—twice the rated voltage of the circuit to which the apparatus is to be connected—except, of course, on machines for very low voltage, on which tests are made at a voltage much higher in proportion. There would be no sense in testing a 100 volt machine at 200 volts; but when you come to 10,000 volt apparatus, the test which experience has shown is sufficiently high, but not too high, is 20,000 volts, which really means four times the normal voltage strain. The reason that this is necessary is because of the abnormal conditions of operation which may occur. On a high voltage system, if one side of the winding becomes grounded, the whole rated potential is exerted between the winding and the iron; and in normal operation, during conditions which we must expect frequently, voltages occur which last but for a small fraction of a second that are as high as the testing voltages of the apparatus. No insulating material can stand higher voltages momentarily than continuously. It would not be safe to lower the testing voltage. Once it was done. It was very difficult to test alternators at double voltages. At that time a 20,000 volt alternator could be built that could be tested at 30,000 volts, but which would not stand 40,000 volts. Since the engineers agreed that it would be desirable to have such alternators, they asked the Standardization Committee to lower the specification for high voltage apparatus to 1½ times the rated voltage. All kinds of breakdowns followed the introduction of this practice, and we came back to the double voltage, and experience has shown that the double voltage is not too high and not too severe a test.

Then going further, overload capacities is another point. Very great difficulty existed formerly in comparing our apparatus with foreign makes, and it has often been noticed how superior the continental companies are in their designs; how much smaller and cheaper their smaller motors are; but they do not follow the Institute rules, and a 5 h. p. motor may mean a very different thing with them from what it does with us. It may mean a motor which can give power at but 5 h. p. or it may mean a motor which can continuously carry power averaging 5 h. p.; sometimes going below that figure. The tendency here in America has been to rate the apparatus at the average output which it can give. Without any guidance of standardization rules, the tendency has been very often to rate apparatus at the maximum which it can perform. Naturally, where these two classes of apparatus are compared, the one appears very much larger and more expensive than the other. The uniform rating which has been established as a minimum is 25 per cent overload for two hours, and for motors or apparatus which may go out of service by reason of excessive overload, 50 per cent overload for one minute. One minute means that it shall be able to carry 50 per cent overload at least, without stopping, falling out of step, or doing anything to interrupt operations.

Now as to temperature rise: The uniform rating of 50 deg. C. rise by resistance and 40 deg. C. by thermometer has been established for all apparatus, with a few exceptions. Commutators and brushes are, allowed 5 deg. C. more. In looking over these specifications we must naturally realize that they do not attempt to represent best practice, but the maximum safe value. It does not mean best practice to specify 50 deg. C.; very commonly 40 deg. C. is called for. In drawing up general specifications, it is not safe to permit a rise of more than 50 deg. C.

I have spoken of Standardization Rules, but really, as they stand at present, they constitute a list of all electrical apparatus, and very few, if any, kinds of apparatus which is used or contemplated in any electric light or power system, are not mentioned, described and classified in those rules sufficiently for an engineer to be able to handle them and know what to do with them, and specify their performance. In this respect they are more complete than any text book of electrical engineering I know of, for during the last twelve years so many people have worked on them, studied them, and discussed them, that they have really become a very complete compendium or dictionary of electrical apparatus in the matter of its performance and test.

EXAMINATION FOR HYDRAULIC ENGINEER.

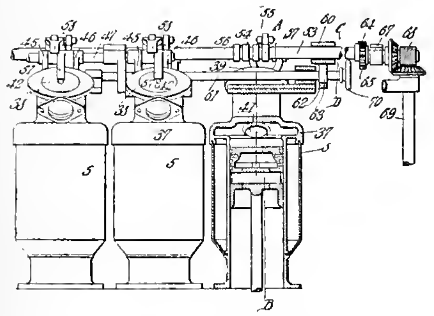
The United States Civil Service Commission announces an examination on February 16,17, 1910, to fill vacancies as they may occur in the position of hydraulic engineer in the Water Resources Branch of the Geological Survey. The salaries range from $1200 or less to $2400 per annum and will be determined chiefly by the character of the training and experience of the eligibles.

The examination will consist of the subjects mentioned below, weighted as indicated:

Subjects.	Weights.
1. Mathematics	5
2. Plane surveying	5
3. Irrigation engineering	10
4. River hydraulics	15
5. Water power engineering	15
6. Training and experience (rated on application)	50

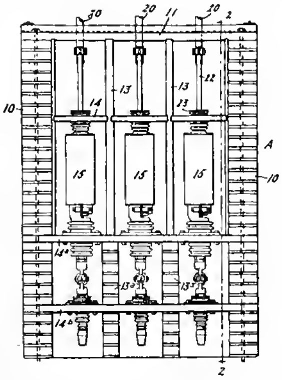
PATENTS

945,393. **Internal-Combustion Engine.** William H. Hollopeter, Portland, Ore. In an internal combustion engine provided with inlet and exhaust valves, a means for operating said valves comprising rock arms for moving the valves to the



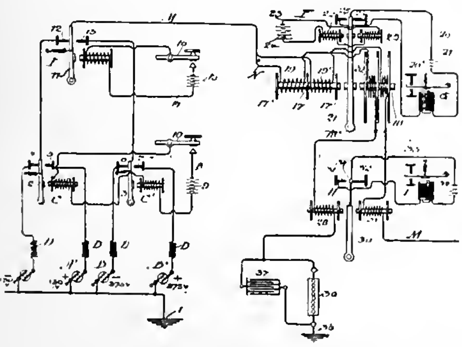
open position, a cam shaft for operating the rock arms and capable of longitudinal movement, and bearings for said shaft movable about an axis parallel and displaced with reference to the longitudinal axis of the shaft.

945,671. **Oil-Switch.** Henry P. Ball, New York, N. Y., assignor to General Electric Company. An electric switch con-



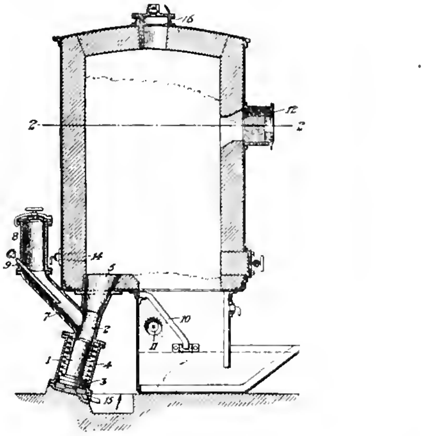
tact comprising two annular guides, and a contact ring consisting of a plurality of laterally yielding contact segments interposed between said guides and annular channels in said contact ring engaged by said guides.

945,018. **Electromagnet.** Lawrence Connell, Jr., Portland, Oregon. Filed July 2, 1906. In an electromagnet the combination of two magnet members, one having a relatively small



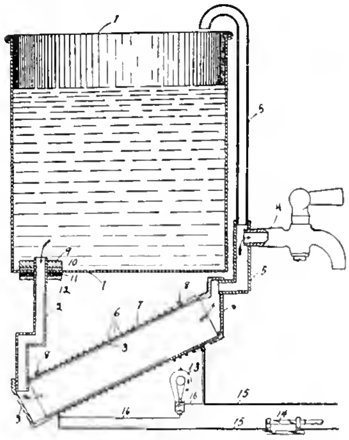
core and high winding and the other a relatively larger core and low winding, an armature associated with said magnet members and arranged to be acted upon by the latter in opposition to each other, and a source of electric energy connected with and common to both magnet members, whereby they are simultaneously energized and act in opposition to each other and the magnetic strength of one or the other preponderates as the amplitude of the current varies.

945,715. **Apparatus for the Manufacture of Gas.** Alexander M. Gow, Edgewood Park, Pa., assignor, by mesne assignments, to The Westinghouse Machine Company. The combination in a gas producer, of a gas generating chamber provided with a fuel admission aperture, a blast admission port located below said aperture and a gas delivery port located



near the top of said chamber, a reciprocating plunger for forcing successive charges of fuel through said aperture in a line substantially parallel to the walls of the chamber, means for introducing fuel ahead of said plunger and a water sealed ash removal port communicating with said chamber and located below said blast admission port.

945,027. **Electric Liquid-Heater.** Oscar H. Fiddes, San Francisco, Cal. In an electric liquid heater, the combination of a liquid heating chamber, a coil of resistance wire around the



same, a reservoir above the heating chamber, a pipe connecting the bottom of the reservoir to the bottom of the heating-chamber, a vent-pipe leading from the top of the heating-chamber to the atmosphere above the top of the reservoir, and a stop-cock on the vent-pipe above the bottom of the reservoir.

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POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Low Frequency Motors

The excellent showing made by the 15 cycle single phase series motor in the Visalia electrification in central California does much to confirm the preference for this frequency as expressed nearly three years ago by Mr. L. B. Stilwell, the present president of the American Institute of Electrical Engineers, and Mr. H. St. Clair Putnam, in a paper read before the Institute in 1907. These engineers stated that "The fundamental, and, as it would appear, controlling reason which leads to this conclusion is the fact that within given dimensions a materially more powerful, efficient and generally effective single phase motor can be constructed for 15 cycle operation than is possible if 25 cycles be secured."

This question is again being agitated this week at the New York meeting of the Institute in a paper, "On the Space Economy of the Single Phase Series Motor," by William S. Franklin and Stanley S. Seyfert. They demonstrate that a reduction of the frequency increases the power factor of a motor, thereby showing the importance of using low frequency alternating current for a single phase series motor.

Federal Charter for Corporations

President Taft has submitted to Congress the first of his special messages dealing with questions not treated in his regular message of last November. This document is principally concerned with proposed changes in the laws governing corporations. In its entirety it is characterized by a frank recognition of existing conditions and the disastrous result of making any sudden change. If President Taft were an engineer, and not a lawyer, he might have likened the damage to our material prosperity that would result from abruptly checking its onward course, to the danger of throwing a tie in front of a rapidly moving express train. Modern methods of business are the result of evolution; it is folly to attempt to change them by revolution.

The President indicates that the consolidation of plants and capital have lowered the cost of production, and produced economy in management to which may be ascribed much of our commercial supremacy. He shows how it is possible for a corporation to secure the benefits of organization without violating the laws, but he also realizes that there are monopolies engaged in the illegal restraint of trade. Their securities are widely distributed among thousands of innocent investors. Their employes and the tradesmen dependent upon them are guilty of no wrong-doing. The President fears the result of hasty enactment of drastic legislation, and offers in lieu thereof a sane and conservative method by which the needed changes may be gradually accomplished.

His most significant statement is that the wrongdoers are to be punished. This will be done without harming the business interests of the country. He therefore proposes that all corporations doing an interstate business be invited to reorganize under a Federal charter, that will provide for public supervision, thus fostering "a continuance and advance of the highest industrial efficiency without permitting industrial abuses."

PERSONALS.

John Martin has returned to San Francisco from the East.

A. M. Hunt, consulting engineer, has returned to San Francisco from the South.

Andrew Carrigan won the golf tournament at the outing of the Pacific Coast jobbers at Del Monte, California, last week.

W. J. Davis, Jr., Pacific coast engineer of the General Electric Company, has gone to Los Angeles for a short business trip.

Frank H. Short, has been spending a few days in San Francisco, after his Eastern trip, before returning to his home in Fresno.

E. J. Koppitz has been appointed chief engineer of the San Vicente Lumber Company with headquarters at Santa Cruz, California.

M. H. Grover, manager San Vincente Lumber Company, was in San Francisco Wednesday and Thursday, making purchases for his electric plant.

George H. Tinker has been made general manager of The Caldwell Bros. Co. of Seattle and Louis Walber manager of the machine tool department.

C. F. Elwell, president of the Poulson Wireless Telephone and Telegraph Company, has returned from the East with C. Schou, C. Albertus and P. L. Jensen, engineers from Copenhagen.

A. L. Wilcox, formerly chief of construction for the Pacific Gas & Electric Company, is now with the San Francisco Fireproofing Company, with headquarters in the Metropolis Bank Building, San Francisco.

C. H. Rattray, a construction engineer of the General Electric Company, has gone to Skagway, Alaska, to install a Curtis steam turbine generator. It will supply current to the White Pass & Yukon Railroad Company for lighting and power.

C. R. Dederick, formerly secretary and treasurer of the New England Electric Company of Denver, Colorado, has recently gone into the jobbing business at Portland, Oregon, The firm name is Dederick Electric Supply Co.; location 86 Seventh street.

R. J. Cash, Jr., a salesman for the General Electric Company, with headquarters in Portland, was a visitor in the company's San Francisco office during the past week. He reported considerable activity in power and lighting business for this time of the year in his territory.

Wynn Meredith of Sanderson & Porter's San Francisco office, left last Thursday for Victoria, B. C., on business connected with a large extension of the electric power plant of the Vancouver Island Power Company. Mr. Meredith's trip will be extended on to New York and he will return via the South after an absence of about six weeks.

Cyrus Avery Whipple, recently engaged in developing the power system of the U. S. Navy Yard at Bremerton, has resigned to accept the position of assistant electrical engineer of the British Columbia Electric Co., Ltd., of Vancouver, B. C., in the construction of its Fraser Valley power and railway system which extends sixty-four miles up the valley and provides light and power to the towns along the route, besides passenger and freight service.

OBITUARY.

John Waller, an expert lineman, employed by the San Joaquin Light and Power Company of Fresno, Cal., was electrocuted January 6th while stringing wires on the company's line near Crane valley. He pulled a telephone wire with which he was working into contact with a high potential power wire carrying 30,000 volts, and the current passed through his body, causing instant death.

Albert McBride of Port Costa, employed at the substation at the foot of the 234-foot north tower of the Pacific Electric Company's transmission cable across the Carquinez Straits, was instantly killed January 6th by coming in contact with the high-tension current at the top of the tower. McBride's body produced a short circuit and temporarily interrupted the service.

IN MEMORIUM.

(By one of his associates.)

Phineas Kellog Guild, known to many of the younger generation of the electrical fraternity, departed from this life on the sixth day of this new year.

"Pete," as he was affectionately termed by his associates, made his acquaintances his life-long friends by virtue of his frank, old-fashioned honesty, his earnestness and the attributes which make sterling character, softened with a kind and gentle nature which lived beneath his rugged frame, but beamed in his every act. True to the strain of his forefathers which gave us the Lincoln and the Guilds. Never was heard from him an ill word against any man, and the love he gave was given him. The kind and gentle heart which made him beloved, throbbed in ecstasy for his two beautiful little ones and the stricken wife, who grieve at its stillness.

His business transactions were characteristic of their creator and were distinguished for their exactness and their definiteness in every detail. For some years he was manager of one of the trading stations of the Alaska Commercial Company in Alaska, and later superintendent of the Cloverdale Light and Power Company in California. He became identified some two years ago with the San Francisco sales force of the Westinghouse Electric and Manufacturing Company, and successfully handled their business in Northern California. Taken, as he was, a simple child of nature fresh from her green hills, and thrown into the seething vortex of competitive and complex commercialism, he struggled bravely against this force, which eventually shattered the sensitive nerves, deranged the beautiful mind and claimed this noble one as its sacrifice.

TRADE NOTES.

The National Wood Pipe Company of Portland recently completed the installation of one-half mile of 8-foot wood pipe line for the Entiat Light & Power Company, Wenatchee, Wash.

The Southern Pacific Company announces that a personally conducted Mardi Gras excursion train will leave San Francisco for New Orleans on January 29, 1910, at a round-trip price of $67.50.

The Portland Cement Company will begin immediately construction of a 1500 barrel plant at Oswego, Oregon, to duplicate their present plant at El Paso. It will be run by electricity; 1700 k. w. plant.

The Oregon Iron Works is installing at Oswego two 500 k. w. hydroelectric units, generators, Westinghouse 3-phase, driven by Pelton-Francis turbine; normal operation head, 87 feet. The source of water is Tuwallatin River; storage reservoir at Sucker Lake, 3½x½ miles, two 4-foot continuous stave pipe lines from the reservoir to the power house, 1200 feet long. The installing engineers, Pacific Electrical Engineering Company. The plant is to be completed in 90 days.

The Multnomah Mohair Mills is installing at Sellwood a 150 k. v. a. Westinghouse Generator, 3-phase, 60 cycle, 220 volt; Skinner automatic engine 15x15; Kewanee boiler 78x18; return tubular, and 42-inch horizontal McCormick water wheel. They will have individual motor drive, 28 Westinghouse, 3-phase motors, aggregating 177 h. p.. A brick plant has been built and the installation of steam heating and fitting is being done complete by the Pacific Electrical Engineering Company of Portland. It will be completed early in February.

NEWS OF THE STATIONARY ENGINEERS

PREAMBLE.—This Association shall at no time be used for the furtherance of strikes, or for the purpose of interfering in any way between its members and their employers in regard to wages; recognizing the identity of interests between employer and employe, and not countenancing any project or enterprise that will interfere with perfect harmony between them.

Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the business of the Association, and at all times preference shall be given to the education of engineers, and to securing the enactment of engineers' license laws in order to prevent the destruction of life and property in the generation and transmission of steam as a motive power.

California.

No. 1. San Francisco, Thursday, 172 Golden Gate Ave. Pres., P. L. Ennor. Sec., Herman Noethig, 816 York St.

No. 2. Los Angeles. Friday, Eagles' Hall, 116½ E. Third St. Pres., J. F. Connell. Fin. Sec., Harry Notthoff, 1307 Winfield St. Cor. Sec., W. T. W. Curl, 4103 Dalton Ave.

No. 3. San Francisco. Wednesday, Merchants' Exchange Bldg. Sec., David Thomas, 914 O'Farrell St.

No. 5. Santa Barbara. Geo. W. Stevens, 2417 Fletcher Ave., R. R. No. 2.

No. 6. San Jose. Wednesday. Pres., W. A. Wilson, Sec., Lea Davis, 350 N. 9th St.

No. 7. Fresno. Pres., A. G. Rose. Sec., E. F. Fitzgerald, Box 651.

No. 8. Stockton. Thursday, Masonic Hall. Sec., S. Bunch, 626 E. Channel St. Pres., H. Eberhard.

Oregon.

No. 1. Portland. Wednesday, J. D. Asher, Portland Hotel. Pres., B. W. Slocum.

No. 2. Salem. A. L. Brown, Box 166.

Washington.

No. 2. Tacoma. Friday, 913½ Tacoma Ave. Pres., Geo. E. Bowman. Sec., Thos. L. Keeley, 3727 Ferdinand St., N., Whitworth Sta.

No. 4. Spokane. Tuesday. Pres., Frank Teed. Sec., J. Thos. Greeley, 0601½ Cincinnati St.

No. 6. Seattle. Saturday, 1420 2d Ave. Pres., H. R. Leigh. Sec., J. C. Miller, 1600 Yesler Way.

Practical letters from engineers and news items of general interest are always welcome. Write your items regardless of style. Communications should be addressed to the Steam Engineering Editor.

PRACTICAL MECHANICS.

Paper No. 3.—Machines and Their Motions.

Professor Alex B. Kennedy has defined a machine as "a combination of resistaut bodies whose relative motions are completely constrained, and which serve by these relative motions to transform the energies at our command into any special form of work."

The points of this comprehensive definition which merit careful notice are:

First—That a combination of bodies is necessary to constitute a machine.

Second—That the bodies must be resistant.

Third—That their relative motions must be completely constrained.

Fourth—That motion is an essential condition, as otherwise energy will not be transformed.

We must therefore have at least two bodies for a machine and their motion relative to each other must be completely constrained by some form of contact. The form of the portions in contact will determine this motion.

If this contact is a surface contact we designate the two portions as a lower pair.

If but a point or line contact, they are called higher pairs.

The most familiar forms of machine contacts are lower pairs, the journal and bearing being a case of pure rotation, while the prismatic guide of the steam engine is an example of a lower pair in rectilineer translation.

In our next paper we will take up the determination of the instantaneous center in a general case and then consider its application to the determination of relative linear velocities and relative angular velocities.

EFFICIENCY TESTS OF MELVILLE GEAR.

In a recent issue of Power and the Engineer it is stated that when the Melville and Macalpine experimental reduction gear was first erected and started on September 7, 1909, extensive preparations had been made to determine the efficiency of the apparatus on the assumption that there might be a transmission loss of at least 5 per cent. After calculating the results of a few preliminary trials, it was found that the apparent efficiency was over 98 per cent, and this raised the perplexing question as to how to determine this unexpectedly small transmission loss with a satisfying degree of exactitude.

According to H. E. Longwell, an endurance test at maximum load and speed was started at 3:15 p. m., on October 16, 1909, and continued until 7:15 a. m. on October 18, or a total of 40 hours. The load was applied by hydraulic dynamometer. During this trial the following average conditions were maintained:

Net weight on scale, lb	4055.4
Speed, r.p.m.	300.06
Brake horsepower	6048

There was nothing in the operation of the gear to indicate that this load might not be carried indefinitely.

There being no way in which to measure the indicated horsepower of a steam turbine, it became necessary to establish the exact brake horsepower in some other way. There is one characteristic of the steam turbine that makes it possible to calibrate any particular machine, in such a way that its output in effective horsepower at any instant may be determined with greater accuracy than it is possible to determine even the indicated horsepower of a reciprocating engiue. As long as the speed and exhaust pressure are maintained constant, the absolute inlet pressure of commercially dry steam, at any instant, is a very accurate measure of the brake horsepower the turbine is developing.

By substituting for the reduction gear a dynamometer connected directly to the turbine shaft, and operating the turbine at a fixed speed, and with a constant vacuum in the exhaust pipe, the inlet pressures corresponding to different loads at this speed may be determined.

While the efficiencies as calculated from these observations are consistent and uniform over the whole range of observations, a check of the efficiency figures was made as follows:

The gear is lubricated by circulating a copious supply of oil under a head of about 10 pounds, through the bearings, and through a spray which plays continuously on the teeth of the wheels. The transmission loss in the gear, therefore, appears as heat in the oil. The heated oil coming from the gear is passed through a cooler which is very like a surface condenser with cold water circulating through the tubes. By measuring the quantity of oil circulated and noting the rise in temperature in passing through the gear, a close approximation of the number B.t.u. lost per hour in friction is obtainable.

Giving due weight to both methods of measurement, it was found that at approximately 500 horsepower, with the turbine running at 1500 revolutions per minute, the efficiency of the gear is more than 98.5 per cent. Less elaborate and extensive determinations show an efficiency of 98 per cent.

PERSONALS.

Chas. S. Olmstead, chief engineer of Hotel Del Monte, was a visitor to San Francisco during the first of this week.

C. A. Eastwood has succeeded C. E. Stevenson as chief engineer of the San Francisco Gas & Electric Company's Station "A," It is understood that the latter, who occupied the above position, for six years has accepted a position at Coalinga in connection with the Pauson oil interests.

APPROVED ELECTRICAL DEVICES

CABINETS

FA. Formed and built-up steel boxes and steel lined wooden boxes, including types Nos. 236, 336, 136 and 436. With or without slate gutters and with wood or steel fronts, with or without glass panels. Approved Dec. 14, 1909. Manufactured by

Frank Adam Electric Co., 904-914 Pine St., St. Louis, Mo.

CONDUIT BOXES, FLOOR OUTLET.

"Fullman" Watertight Floor Outlet Boxes, adjustable and non-adjustable types. Non-adjustable, Cat. No. 481. Adjustable, Cat. Nos. 402, 403, 404, 422. Also gang boxes, Cat. Nos. 448 to 452 inclusive, with adjustable frame for leveling the cover of box. All the above with brass cover plates and outlet nozzles. Approved Dec. 20, 1909. Manufactured by

Steel City Electric Co., 1207 Washington Ave., Pittsburg, Pa.

CONDUIT, UNLINED.

"Electroduct" and "Xduct." Approved Dec. 1, 1909. Manufactured by

American Circular Loom Co., 45 Milk St., Boston, Mass.

FIXTURES.

Tungstolier Folding Fixtures—straight electric. These fixtures are completely wired and are of special design which permits them to be packed in a small compass. Anti-vibratory suspensions are used as a protection for the Tungsten lamps. Approved Dec. 20. 1909. Manufactured by

The Conneaut Company, Conneaut, Ohio, for Tungstolier Company, Cleveland, Ohio.

LAMP ADJUSTER.

"Eclipse" Lamp Adjuster. Mechanical system consisting of a fixed and movable pulley with cord passing over the same, arranged to support an incandescent lamp. With approved re-enforced portable cord having outer rubber jacket and braid over the whole, such conducting cord may be used to run over the pulleys. With approved pendant cord a separate cord or small rope is arranged to pass over the pulleys, suitable clamps being provided for attachment to the conductor. Approved Dec. 20, 1909. Manufactured by

J. W. Carter & Co., Abilene, Texas.

PANELBOARDS.

Metering panelboards. Two or three-wire, 125 and 250 volts. "McWilliams Universal"; with knife switches and cartridge enclosed fuse cutouts in branch circuits. "McWilliams Meterite"; employing a special type of construction having screw rings formed in the branch bus bars to serve as receptacles for Edison plug fuses. Approved when installed in approved cabinets; Dec. 24, 1909. Manufactured by

J. Lang Electric Co., 421 N. Lincoln St., Chicago, Ill.

RECEPTACLES, STANDARD.

"P. & S." 3 A., 250 V., Cleat, Cat. Nos. 61870 (870), 61871 (871), 64369 (821) and 66612 (822). Moulding, Cat. Nos. 61670 (670), 61770 (770), and 100136. Sign or Conduit Box Type, Cat. Nos. 975, 61072 (1072), 61777 (777), 61973 (973), 61977 (977), Removable Ring Types, Cat. Nos. 61577 (577), 61578 (578), 61877 (877), 61988 (988), also 61900 (900), for use only in borders of double faced metal panel signs, and 61960 ready wired for sign work with receptacles spaced 4 inches on centers. This receptacle is also furnished wired with No. 12 or No. 14 wire and with spacings 5-30 inches on centers. Condulet Receptacle, Cat. No. 88259. Approved Dec. 17, 1909. Manufactured by

Pass & Seymour, Inc., Solvay, N. Y.

RECEPTACLES, WEATHERPROOF.

"P. & S." 3 A. 250 V. Cat. Nos. 820, 61160 (1160), 61161 (1161), 61163 (1163), 61972 (972), 61974 (974), and 62358 (872). Also Cat. No. 61971 (971) for use only when installed where exposed to rainfall. Approved Dec. 17, 1909. Manufactured by

Pass & Seymour, Inc., Solvay, N. Y.

RHEOSTATS.

"C. H." Lever type treadle controller 1-7 to 1-4 h. p. 125 or 250 v. Combination motor starting and speed control device operated by means of a spring actuated rod attached to the moving contact arm. Approved Dec. 20, 1909. Manufactured by

The Cutler-Hammer Mfg. Co., Milwaukee, Wis.

SOCKETS, STANDARD.

"P. & S." Brass Shell Sockets. Key, "Snap Cap" Cat. Nos. 440, 442 and 444, "Bayonet" Cat. Nos. 61059, 61060, 61063, 61065, 61157 (157), 61357 (357), 61457 (457), and 61557 (557). "Protectus" Cat. Nos. 100421, 100423, 100425, 100427-100429 incl. "Passmour" Cat. Nos. 100412, 100414, 100416, 100418-100420 incl. Keyless, "Snap Cap" Cat. Nos. 441, 443 and 445. "Bayonet" Cat. Nos. 60157 (0157), 60357 (0357), 60457 (0457), and 60557 (0557). "Protectus" Cat. Nos. 100422, 100424, and 100426. "Passmour" Cat. Nos. 100413, 100415 and 100417. Also the above types with shadeholders attached. Approved Dec. 17, 1909. Manufactured by

Pass & Seymour, Inc., Solvay, N. Y.

"P. & S." Porcelain Shell Sockets. Key, Cat. Nos. 61217 (217), 61227 (227), 61317 (317), and 61327 (327). Keyless, Cat. Nos. 60217, (0217), 60227 (0227), 60317 (0317) and 60327 (0327). Approved for use only in places where they will not be exposed to hard usage; Dec. 17, 1909. Manufactured by

Pass & Seymour, Inc., Solvay, N. Y.

SWITCHES, AUTOMATIC.

"Economy" Time Switch, 6 A., 125 V., 3 A., 250 V. An alarm clock mechanism arranged to open lighting circuit at predetermined time by operation of an approved pendant snap switch. Report December, 1909. Features criticised include the following: Marking not complete; manufacturer does not show suitable case for enclosing switch and clock mechanism. Dec. 22, 1909. Manufactured by

Economy Time Switch Company, Herington, Kans.

SWITCHES, COMBINATION CUT-OUT.

"Hill" 30 A., 250 V. Knife switch and Edison plug cutouts, mounted on a porcelain base. Approved Sept. 23, 1909. Manufactured by

Taunton-New Bedford Copper Co., Taunton, Mass.

SWITCHES, PENDANT SNAP.

"C. H." 6 A., 125 V., 3 A., 250 V., and 10 A., 125 V., 5 A., 250 V. Approved Nov. 11, 1909. Manufactured by

The Cutler-Hammer Mfg. Co., Milwaukee, Wis.

"Inductor Compensator" Type B. A transformer for use in arc lamp circuits of moving picture machine outfits. Primary voltage 110, Secondary ampers 35-60. Approved Nov. 15, 1909. Manufactured by

Don J. Bell, 217 W. Illinois St., Chicago, Ill.

WIRES, SLOWBURNING.

Insulation consisting of three braids. See Rule 43, National Electric Code. Tag on coil to read, "Nat'l Elec. Code Standard." Marker: Yellow thread woven in inner braid. Approved Nov. 8, 1909. Manufactured by

The Wire and Cable Co., 241 Guy St., Montreal, Canada.

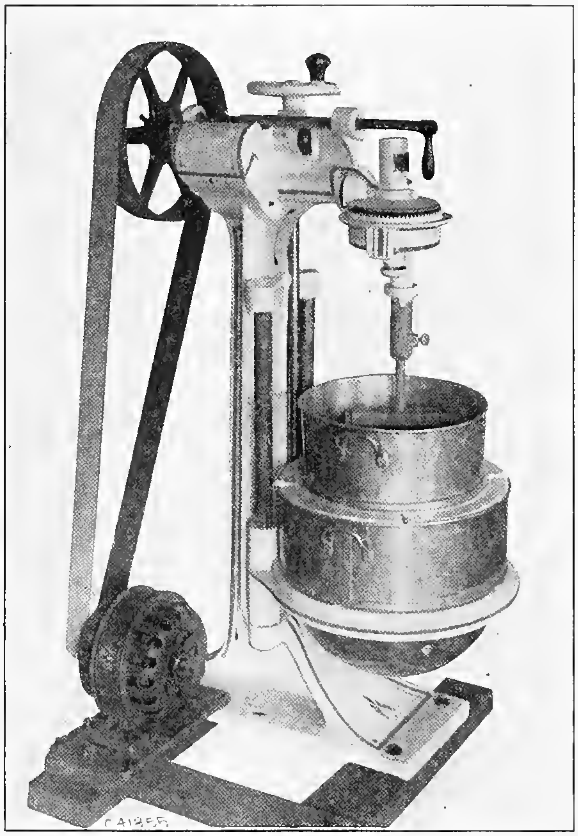
INDUSTRIAL

A MOTOR-DRIVEN DOUGH-MIXER.

Modern electrically-driven machinery has lightened the work of the large kitchen and bakery just as it has taken an important place in other lines of production where methods of manufacture are more completely standardized.

The tedious labor of dough-mixing, egg-beating, etc., is performed economically and quickly by the electric motor, while the work done is considerably more thorough than that accomplished by human agency. The superior sanitary advantages of the electrically-driven apparatus are also important considerations in the preparations of a foodstuff. Moreover, the mixture is assured to be uniformly and completely worked, without the attention of a skilled operative or baker.

A useful form of cake-mixer and egg-beater is shown in



Motor Driven Dough Mixer.

the accompanying illustration. This shows a one-half horsepower Westinghouse alternating-current motor driving a "Baby Grand" dough-mixer, built by the Read Machinery Company, York, Pa. The little motor, which is of the two-phase, 60-cycle, "CCL" type, runs at 1740 revolutions per minute, driving the pulley on the mixer at 350 revolutions. Through the arrangement of a nest of gears, three speeds are obtainable at the mixer paddle.

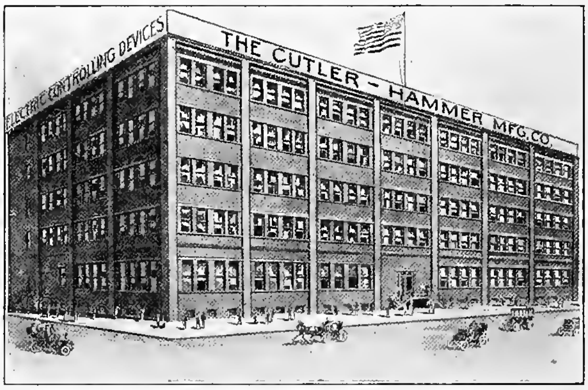
The model shown has its pan equipped with a hot-water bath for making warm batches. In the size of machine shown, two pans are provided, of five and ten gallons capacity, respectively. Several different paddles are also furnished, each especially suited to some certain consistency of the mixture and the speed at which it is to be worked. The pan is raised and lowered by the handwheel and worm seen paralleling the standard.

Special attention is called to the peculiar motion described by the mixing paddle which, by an arrangement of plantetary gears, is kept rotating while it revolves about the center of the pan. The resulting "cutting" and mixing action is most similar to that of hand-mixing, and produces a quality of batch which is nearest like that of the hand-mixed dough. The result is obtained, however, much more quickly and thoroughly than is possible in the old hand-kneading processes.

NEW YORK FACTORY OF CUTLER-HAMMER MFG. CO.

The Cutler-Hammer Mfg. Co. of Milwaukee, Wis., has recently completed a new factory in New York City devoted to the manufacture of electric controlling devices. The new building is in the Borough of Bronx, facing on Southern boulevard, 144th street and Timpson place. It is five stories in height, contains about 100,000 square feet of floor space and is of steel and brick construction throughout.

Electric current for light and power is furnished by the New York Edison company, but provision is also made for an



New Factory of Cutler-Hammer Mfg. Co.

isolated, steam-driven electric plant in the basement of the building. The new factory also has a complete equipment for transforming the alternating current furnished by the electric company into direct current, the latter being preferable for the operation of machine tools.

The building is equipped with a thoroughly modern sprinkler system, including roof storage tanks of 50,000 gallons capacity, and a 100 horsepower electrically operated centrifugal fire pump with its 50,000 gallon cistern in addition. This together with the substantial construction of the building itself, the excellent light afforded by reason of its location on three streets and the complete electric equipment for light and power make the Eastern plant of The Cutler-Hammer Manufacturing Company unquestionably one of the finest factory buildings in New York City.

NEW CATALOGUES.

Bulletin 6F from the Engineering Department of the National Electric Lamp Association is devoted to the tungsten 250-watt multiple lamp, 100-125 volts. It also contains valuable notes on illumination data and cost analysis, including revised data on all tungsten 100-125-volt multiple lamps.

THE SILENT WAVERLEY AT THE GARDEN SHOW.

The display of Waverley Electrics at the Madison Garden Show in New York, January 8 to 15, 1910, included all their 1910 models.

The popular 75-C, four-passenger brougham, leads all others in sales this winter and attracted the chief attention of visitors. The lines of this car distinguish it from all other brougham or coupe designs that will be exhibited at the show and have a peculiar grace and quiet elegance that impress more the more closely the design is studied. The distinctive feature is the drop sill which is copyrighted, and therefore not found in other electrics. This makes possible the combination of a true victoria body with the chaste lines of the removable brougham top, a most effective and satisfying whole. Other electric coaches are usually built on a straight sill and follow the less graceful curves of the stanhope body design.

Twenty-eight different painting operations are employed in giving the Waverley coach bodies their perfection of finish; while the upholstering is in rich broadcloth or substantial leather of harmonious shades. The ample plate glass windows are furnished with silk curtains and the ceiling is upholstered in expensive satin. An imported broad lace of new and elaborate pattern marks the panels of the doors, seats and windows. The floor cloth is a Wilton rug.

The carriage is operated from within, the steering lever and interlocking controller being at the left of the rear seat with the volt-meter and double foot brakes immediately in front. Accident proof, trouble proof, practically fool proof is the character given to the Waverley controller, whose simplicity of operation and absolute safety may easily be demonstrated to any visitor.

The driving mechanism of the silent Waverley is a transverse shaft drive attached to the body, completely encased and protected from dust and dirt and running in a continuous bath of oil. The power is transmitted from the motor through a silent flexible gear to the transverse shaft and then by a herring-bone gear to the floating rear axle. Efficiency, noiselessness, and a complete absence of those numerous annoying troubles that go on the one hand with chain and sprocket drives and on the other with propeller-shaft, bevel-gear drives, are the characteristics of the Waverley transverse shaft drive, which is attached to all the Waverley models on exhibition at the show and is also mounted by itself and exhibited in active operation.

The Waverley motor is larger than other electric carriage motors, built with unusual strength of parts, great efficiency and remarkable overload capacity. Choice of Exide, Waverley or National batteries is supplied with Waverley carriages, and in Model 75-C the battery is divided, 20 cells in the rear compartment and 12 in front, all of 11 or 13 plates as specified.

In this respect the mechanism of the brougham differs from that of the new Waverley roadster, model 78, a thoroughly unique car built on the lines of a gasoline runabout. The peculiar racy effect of this "man's electric" is obtained by combining 32 cells of battery all under a long front hood. The wheel steer also marks this car off from other Waverley models in all of which the side lever steer is given the preference, though it is understood that the Waverley factory is in a position to equip any of its cars with steering wheels if desired. Back of the roomy two-passenger seat of the roadster is a tool box surmounted by a folding rumble seat which makes this car accommodate three passengers with ease and comfort. With the exception of the differences noted the mechanism of the roadster is the same as that of model 75-C; but it is equipped for a speed of 25 miles an hour when desired. The car has a long wheel base for an electric, viz.: 94 inches, and the length of the body is 108 inches. It is ironed for a mercerized cape top, and supplied with a wind shield when required, and is in appearance and performance a striking and unusual type of car.

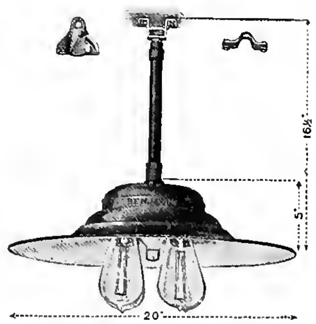
Model 70-C two-passenger coupe is finished and furnished with the same care, taste and completeness as the Waverley brougham above described. It is a carriage of solid popular qualities with a record of fine achievements in regular service as well as in cross country stunts. A car of this model traveled recently from Indianapolis to Terre Haute on a single charge and drove about the streets of the latter town until 86 miles were covered without recharging.

Model 76 victoria phaeton is another extremely popular type of car in the form of a ladies' summer carriage, which may be converted at will into either a brougham or coupe by changing the victoria leather top for a removable coach top. No electric carriage of any type or model has so many devoted admirers among the ladies as the Waverley Victoria. The same carriage may be used with buggy top or canopy top if desired, and is equipped mechanically in precisely the same way as the brougham and coupe.

Finally the Waverley Company is represented by its stanhope, model 74, with buggy top, straight sill and solid tires, a carriage of unusually distinguished appearance and thoroughly practical qualities. It is provided with ample protection for stormy weather, and like the 70-C is famous for numerous cross-country stunts. This car is especially popular with professional men for town and rural service. The practicing physician and visiting clergyman, as well as many substantial business men find it an indispensable vehicle for professional work. Altogether the Waverley exhibit this year is of unusual character and interest.

BENJAMIN TUNGSTEN FIXTURE.

A new tungsten fixture especially adapted for use in factories, shops, warehouses, is being placed upon the market by the Benjamin Electric Mfg. Co. The accompanying cut illustrates its principal features among which are the 20-inch Porcelain Enameled Steel Reflector with 10½-inch inner reflector to assist in the downward radiation of the light,



Benjamin Tungsten Fixture.

8-inch stem of ½-inch iron pipe, and Tungsten Shock Absorber; 40, 60, 100-watt lamps may be used. In three and four-light fixtures the sockets are vertical; in five and six-light fixtures, at an angle of 15 degrees, thus permitting the use of larger units and increasing the lighting efficiency by making it unnecessary for the light of one lamp to pass through the others.

Further information may be secured by addressing the company's office, No. 151 New Montgomery street, San Francisco.

TRADE NOTE.

G. M. Gest, the underground conduit contractor of New York and Cincinnati, has opened an office in the Hooker & Lent Building, San Francisco. The firm has been established in the East for about twelve years and have made a specialty of the installation of underground conduits for electrical distribution. Their initial undertaking on the Coast will be a conduit lead for the Pacific Gas and Electric Company in Oakland, Cal.

NEWS NOTES

FINANCIAL.

TACOMA, WASH.—Weil, Rotch & Co., have been awarded the $100,000 city power plant bonds at $102,155.

BRAWLEY, CAL.—An election was held on Tuesday to vote on bonds for public improvements. Water system bonds for the sum of $40,000 were carried.

PHOENIX, ARIZ.—City Attorney T. J. Prescott, has prepared a resolution for a bond election for a municipal lighting plant which will be submitted to the City Council. The bond issue will be for $300,000.

SANTA CRUZ, CAL.—The City Council has decided to call a special election to vote upon a proposition of issuing $150,000 in bonds for the rebuilding of the water system and for other public improvements.

SEATTLE, WASH.—It is announced by T. A. Davis, manager of the John J. Sesnon Company, Mutual Life Building, that a syndicate of Englishmen represented by Col. Stuart Weatherley, Waldorf-Astoria, New York, has purchased the electrical plant of his company at Nome, Alaska, and that the syndicate has $4,000,000 with which it will develop Alaska mining properties next year.

SAN FRANCISCO, CAL.—The Union Trust Co. as trustee invites bids for the sale to it of a sufficient number of the bonds of the San Diego Electric Railway Co. as shall be necessary for the investment of $75,000. On receipt of bids the lowest bids, if at a price not higher than a 4 per cent basis, will be accepted to the extent of the moneys in the hands of the trustee for that purpose, and bids so purchased will be canceled to that extent. Bids will be opened on the seventh day of February at the office of the Union Trust Co., 2 Montgomery street, San Francisco.

PASADENA, CAL.—At a special meeting of the City Council an ordinance has been passed providing for a special election to be held on January 26 for the purpose of voting bonds for the purchase of plants of the three companies at present supplying Pasadena with water. Bonds will bear 4½ per cent interest. Two propositions will be voted on. One is bonds for $1,000,000 for the purchase of property belonging to the water companies and the other for $200,000 for the purpose of installing necessary improvements. The water companies have given the city options on their property.

SAN FRANCISCO, CAL.—The report of the United Railroads of San Francisco for the month of November and 11 months ended November 30, compares as follows for 1908 and 1909:

	1909.	1908.	Increase.
November gross	$ 619,313	$ 574,521	$ 44,792
Expenses	352,570	316,333	36,237
November net	266,743	258,188	8,555
11 months gross	6,810,119	6,262,900	547,219
Expenses	3,862,446	3,899,680	*37,345
11 months net	2,947,673	2,363,220	584,453

*Decrease.

PORTLAND, ORE.—Four million dollars approximately will be paid by the Electric Share & Bond Co. of New York for the Portland Gas Co. A meeting of the stockholders of the gas company has been called at which time negotiations for the transfer of the gas company will be concluded. The stockholders in the present company have agreed to give up their stock at $130 a share. The bonds and other securities of the company will make the approximate valuation of the plant $4,000,000. The purchase of the gas company by the Electric Share & Bond Co. of New York, a holding company for the General Electric Co., which is, in turn, closely affiliated with the Standard Oil, will mean no change in the management of the local company, according to Herman M. Pabst, general manager of the company. The concern's new owners are closely affiliated with the Portland Railway, Light & Power Co., which controls all electric utilities in Portland, and the sale brings all gas in Portland under the same influence which controls electricity, though not under the same absolute ownership.

INCORPORATIONS.

VANCOUVER, WASH.—The C. W. A. Lumber, Shingle, Light & Power Company, of Vancouver, $50,000; J. M. Cameron, D. S. Cameron and E. H. Wright.

OLYMPIA, WASH.—Centralia-Chehalis Water & Power Company, of Centralia, $250,000; John E. Heasty, L. W. Goodrich, E. S. Price, F. S. Blattner and Clayton W. Quale.

SEATTLE, WASH.—Ideal Irrigation Rotary Pump Company of Seattle, $100,000. H. W. Peterson, James C. Langley and E. E. Peterson.

SAN DIEGO, CAL.—The El Cerrito Park Water Company, with capital of $10,000 has filed articles of incorporation. Directors of the company are Fred Moran, F. E. Patterson, F. L. Sargent and others.

SPOKANE, WASH.—The Washington Southern Telephone Company has been organized with a capitalization of $100,000 to merge the interests of the Montana Independent, the Home and the Interstate Companies, with through connection into St. Paul and traffic arrangements with all independent telegraph and telephone lines out of Salt Lake City. Towns in British Columbia and Oregon will be connected under the new system. The officers are: President, Charles R. Cushman of Spokane; Vice-President and Secretary, Charles M. Cooley of Aberdeen, S. D.

TRANSMISSION.

CHIHUAHUA, MEX.—Quayley Bros. are arranging to install a hydroelectric power at the Yoquivo mine. R. V. Nealy is manager.

OSBURN, IDAHO.—Announcement is made that electric power will be installed this winter at the United Lead Mining Company's property here.

HANFORD, WASH.—The Hanford Irrigation & Power Company is assembling machinery and material for the development of its power at Priest Rapids in the Columbia River. A large wing dam is to be built at the head of the channel.

OROVILLE, CAL.—Fred W. Hecker of this city has filed an appropriation of 80,000 miners' inches of the water of the Feather River. In his notice of appropriation Hecker declares that the water is appropriated for the purpose of developing electric power.

PRINCE RUPERT, B. C.—Notice has been given by Barnard & Robertson of Victoria, as solicitors of the Prince Rupert Power & Light Company of the intention of that association to seek a private act at the coming session of the house confirming the incorporation and powers of the company.

PRESCOTT, ARIZ.—Chief Engineer Masson of the Arizona Power Company gives out information that an extension of the line of his company will be started immediately from Prescott to the camp of the Alvarado Mining Company, at Fool's Gulch. The Alvarado people are now purchasing motors.

ARMSTRONG, B. C.—The Shuswap Falls Light & Power Company is negotiating for the purchase of the local light plant. The company also has under consideration the connection of Enderby, Armstrong and Vernon with Grand Prarie and Salmon River by means of a tramline.

CHELAN, WASH.—The Chelan Electric Company, a subsidiary company of the Great Northern Railway, is making surveys for the location of its dam across Chelan River gorge at a point near Cape Horn, between Chelan and Chelan Falls. This will cost about $5,000,000, and is expected to develop 80,000 h. p., which will be used to run the electric lines of the Great Northern to light cities and to pump water for irrigation from Lake Chelan and the Columbia. This dam will make the gorge above it a great continuation of Lake Chelan, and will raise the whole surface of the lake.

SACRAMENTO, CAL.—All question as to whether or not the Great Western Power Company contemplates entering the local field in competition with the Sacramento Electric, Gas & Railway Company in supplying electric power and lights to private parties in Sacramento was dispelled when E. P. Hilborn, local manager for the company, announced that the contract will be let this week for a sub-station at Eighth and R streets and that some time during the summer the Great Western Power Company will be in this city. The business districts, J and K streets, and the cross streets devoted to business will be first supplied.

WASHINGTON, D. C.—Representative Smith of California has reintroduced his water-power bill. He upholds the principle of granting no titles to natural resources in perpetuity, but he insists that the State shall supervise and tax the companies. He fixes a generation, or the usual bond term, as the time easement shall run, and he urges it as a cardinal point that the grant shall not be made the basis of any capitalization or bond issue. The Congressman disputes the contention that the States are "not ready yet" to grapple with administration of water-power corporations. On every proposition in which Mr. Pinchot argues that the Federal Government shall exercise control Mr. Smith expresses a vigorous disapproval. For practical reasons he regards what he interprets as invasions of the rights of the States as unwise and even deplorable. Taxing and rate regulation he believes to be purely the function of the State and not of a bureau chief "3000 miles away." He is also opposed to the "moderate charge" that Pinchot and Secretary Ballinger insist upon for the use of the easement.

ILLUMINATION.

LOS ANGELES, CAL.—The City Council has passed an ordinance providing for ornamental cast iron posts to be constructed on Pico street from Main to Vermont avenue at intervals of 120 feet.

MONROVIA, CAL.—A high pressure system will probably be adopted by the Monrovia Gas Company to supply Sierra Madre with gas. To do this it will be necessary to install a central station at Sierra Madre.

PASADENA, CAL.—The Board of Trustees of South Pasadena will soon call for bids for the erection of ornamental light posts on Fair Oaks avenue and Mission street. The cost will be borne by property owners.

PAYETTE, IDAHO.—Charles D. Lamson of Boise is asking the city for a 50-year franchise to construct and operate a gas manufacturing plant and lay and maintain gas mains through the streets and alleys of the city.

LOS ANGELES, CAL.—The Trustees of Sierra Madre are advertising a gas franchise for sale, and hope to see gas pipe laid and service started early coming year. Monrovia has a plant and it is a prospective bidder. Glendora and Covina are supplied by gas from the latter city. The Covina Company is also to bid on the proposition.

TRANSPORTATION.

BOISE, IDAHO.—The Boise & Interurban Railway will in the spring erect a two-story brick station at the corner of Seventh and Bannock streets. Plans have been prepared and sent East for approval.

SANTA BARBARA, CAL.—The City Council has passed Ordinance 669 to grant to the Santa Barbara Consolidated Railway Company an electric street railroad franchise on certain portions of Fourth street.

LOS ANGELES, CAL.—The City Council has passed an ordinance granting to Fred W. Forrester the right to construct and maintain a double track electric street railway beginning at Ninth and Park View avenue.

TWIN FALLS, IDAHO.—A franchise has been granted the Twin Falls Electric Railroad & Light Power Company to put in a street railway system. The company is represented by Geo. F. Sprague and W. P. Guthrie.

EL PASO, TEX.—A new electric car line is being projected here, which is to take in Smelter No. 3 and the big nail factory about three miles north of union stables. This is to accommodate resident section being opened in that district.

HOQUIAM, WASH.—The trustees of the Grays Harbor Interurban Company, of which A. L. Paine is manager and P. S. Locke, secretary, have incorporated, with a capital stock of $500,000, for the purpose of building a trolley line between Hoquiam and Tacoma via Olympia.

PENDLETON, ORE.—An agreement has been reached between the Pendleton Commercial Association and the Washington-Oregon Traction Company which secures the completion of six miles of car line within one year, electricity to reach the city in two years, eventually fifty miles of interurban line extending out from this city, etc.

HOQUIAM, WASH.—Articles of incorporation for an extensive interurban trolley system have been filed with the Secretary of State at Olympia. The capital stock is $500,000. The officers are R. F. Lytle, A. L. Pain and E. O. McGlaufin, from Hoquiam; W. H. Abel and Eldridge Wheeler of Montosano, and A. H. Abel and Phil S. Locke, of Aberdeen.

LOS ANGELES, CAL.—E. D. Goode, owner of the Glendale and Eagle Rock Railway, has acquired from the Los Angeles Interurban Railway an old franchise on Fourth street, Glendale, and Geo. Mock, a contractor, has commenced grading between Glendale avenue and Brand boulevard. Track laying will be begun with a week and cars will be operated over the new line on or before the 16th inst.

NEW YORK.—Commenting on the problem of electrification of the Central Pacific over the Sierras Mr. Kruttschnitt of the Southern Pacific Co. says: "Eastern critics may be inclined to the opinion that we are dallying with this matter. We have found that it pays well to make haste slowly with regard to innovations. No road other than the Great Northern has done much with electrification as a solution of the mountain problem. The Great Northern's only important piece of electrification so far is through the 14,000-foot Cascade tunnel, 100 miles east of Seattle, where the grade is only 1.7 per cent. Over the Sierras the Central Pacific must conquer a grade of 7000 feet either way in a total distance of 110 miles, of a grade of almost 2.5 per cent. Electrification for mountain traffic does not carry the same appeal that it did two years ago. Oil-burning locomotives are solving the problem very satisfactorily. So well pleased were we with the behavior of the two compound consolidation Mallets mentioned in the Southern Pacific's last annual report that we ordered 16 more, the last of which are being delivered. Each of these locomotives, having a horse power in excess of 3000, hauls as great a load as two of former types, burning 10 per cent less fuel and consuming 50 per cent less water."

WATERWORKS.

SAN BERNARDINO, CAL.—The storm here last week caused the city's big water main from Antil pumping station to be broken.

ORANGE, CAL.—The Council awarded contract to Fairbanks, Morse & Co. to furnish the waterworks with a boiler. Their bid was $1,766.75.

OAKLAND, CAL.—The contract for the laying of pipes in Lakeside Park was awarded to the Warner Improvement Company, at 17 cents a lineal foot.

REDLANDS, CAL.—The Domestic Water Company expects to begin work in about two weeks on the new 13-inch line on Colton avenue leading from the reservoir.

COTTAGE GROVE, ORE.—Engineer J. W. Roberts has completed an estimate of the cost of the proposed gravity water system. Estimated cost of the system, including a 300,000 gallon reservoir, is $103,319, but it is believed that its construction may be had within the $100,000 voted for the purpose.

PHOENIX, ARIZ.—Sealed bids will be received up to January 20th by the Board of Control of Arizona at its office in the Capitol Building here, at which time and place bids will be opened for furnishing one 50,000 gallon steel tank on a 60-foot steel tower erected complete and ready for use at the Territorial Prison at Florence, Ariz.

TACOMA, WASH.—At the last City Council meeting Water Superintendent H. A. Whitney proposed that a pipe line be built from the city to the Maplewood Springs and that a steam pumping plant be erected at Maplewood for the purpose of pumping water into the low service pipes to supply the city until such time as a gravity system is contemplated.

TACOMA, WASH.—Sealed proposals for the following supplies or work are being received by the commissioner of public works: Construction of a surface water drain of 8-inch pipe from lot 12, block 955, Alliance Addition, along South R street and South Eleventh street to connect with the catch basin at South Eleventh street and Sprague avenue, according to plans and specifications on file in the office of Public Works. Proposals to be on printed form, and accompanied by a certified check for 5 per cent of amount of bid.

COLUSA, CAL.—The Board of Town Trustees opened bids for the new waterworks at its regular meeting last week, but owing to the number of bids and different proposals offered City Engineer Kaerth decided he could not give a definite answer. The firms bidding on the proposed waterworks were Charles Moore & Co., Stanley Contracting Co., Des Moines Bridge & Iron Co., Union Gas Engine Co., Cotton Bros., Krough Mfg. Co., F. C. Roberts & Co., Pacific Drilling Prospecting Co., Chicago Bridge & Iron Works, Cal. Hyd. Eng. & Sup. Co., Doak Gas Engine Co., Union Iron Works, Henry R. Worthington, Standard Engineering Co., and Fairbanks, Morse & Co.

SACRAMENTO, CAL.—The American Canyon Water Company has submitted to the Board of City Trustees a proposition to furnish this city with water from the north fork of the American River. The company agrees to supply the city with 150,000,000 gallons of water daily for $400,000 a year, and $2500 for each additional million gallons. Should this offer be accepted the city would not need the $660,000 filtration plant for which it is about to call a bond election. The matter was referred to the committee of the board and the city engineer for investigation. Should it prove better than a pumping plant to clear the Sacramento River water it may be accepted, but the Trustees are quite firmly set on the filtration project.

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POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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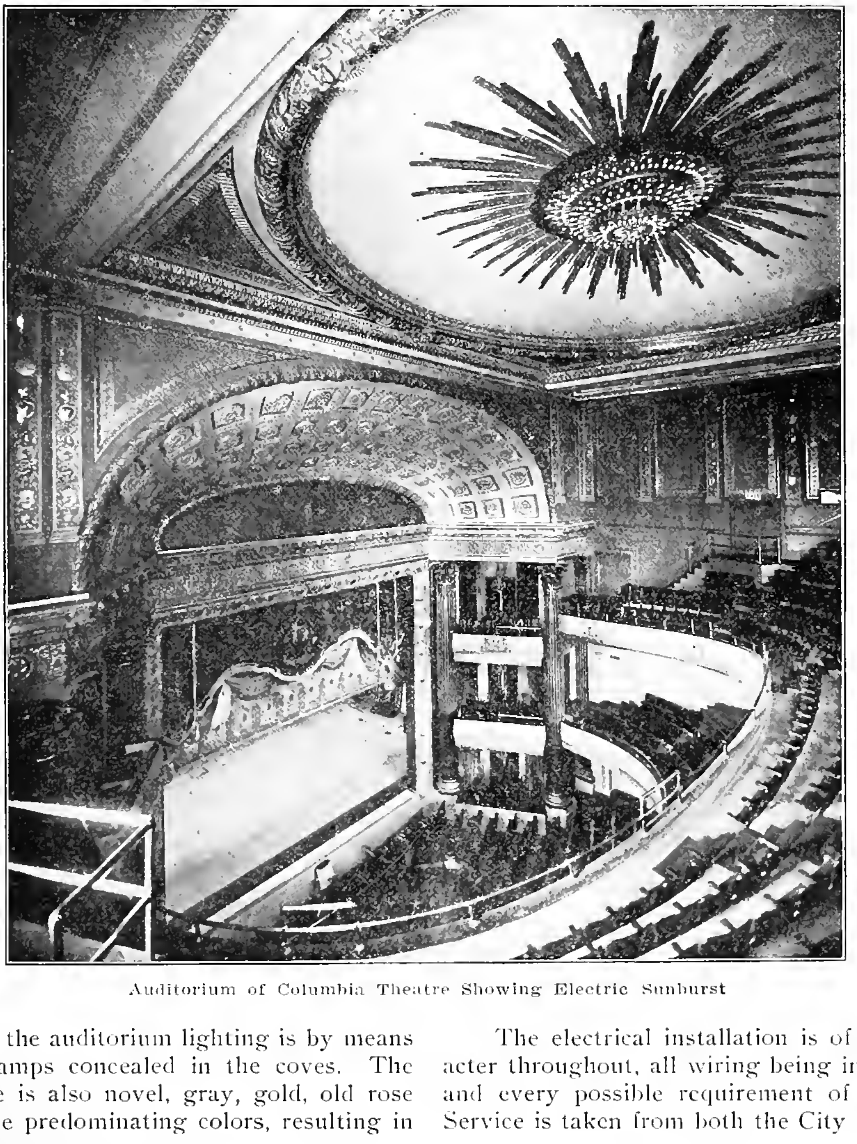
VOLUME XXIV | SAN FRANCISCO, JANUARY 22, 1910 | NUMBER 4

ELECTRICAL EQUIPMENT OF COLUMBIA THEATRE

BY W. W. HANSCOM.

The electrical installation in the recently completed Columbia Theater of San Francisco is somewhat of an innovation in theater lighting in that city, for with the exception of the center dome and proscenium box fixtures all of the auditorium lighting is by means of incandescent lamps concealed in the coves. The decorative scheme is also novel, gray, gold, old rose and blue being the predominating colors, resulting in a combination extremely pleasing and dignified. As it is possible for only an artist to do justice to the architectural and decorative features of the theater these will not be included in this article.



Auditorium of Columbia Theatre Showing Electric Sunburst

The electrical installation is of the highest character throughout, all wiring being installed in conduit and every possible requirement of service provided. Service is taken from both the City Electric Company

and the San Francisco Gas & Electric Company, the former supplying both direct and alternating current and the latter direct current only.

Both services enter the building at the curb in the service board room in the basement, the City Electric Company having installed an independent transformer for the a. c. in a special pit under the sidewalk. From the underground conduits the services are led to the transfer and meter board. After leaving the meters they are connected through triple pole, double throw switches to the main distributing board alongside. The blades of the triple pole switches are connected through Westinghouse triple-pole oil-break switches, mounted on the back of the distributing board, to the distributing bus bars. The oil-break switches are connected to levers in the ticket office on the first floor above so that it is possible in case of emergency to entirely disconnect the building from the street service without delay.

On the distributing board are two sets of bus bars, one for a. c. to supply the entire incandescent lighting, the other for d. c. to supply the motor and arc-light circuits.

All of the lighting in the front of the building is controlled from two panelboards in the ticket office, both of which are connected to the distributing board through separate feeders. To one of these panels are brought all of the circuits supplying the marquis, facade, lobby, office, ladies' dressing room and toilets; to the other all emergency and exit circuits.

By the arrangement of switches on the transfer and distributing boards it is possible to supply all of the light and power circuits from either company or divide them up between either in case of failure of part of the service.

In case of failure of the current supplying the emergency and exit lights panelboard, all of these circuits are automatically switched onto a storage battery located in the building, so that it is practically impossible to entirely deprive the auditorium of light.

Auditorium and stage lighting is controlled from a stage switchboard placed in a fireproof enclosure back and to the right of the proscenium arch in a position which gives the operator a good view of the stage. This board is fed from the distributing board by means of two sets of three-wire feeders, one for a. c. and the other for d. c.

The general arrangement of the stage board is clearly shown in the accompanying illustration. The panel switches on the top panels control all of the general lighting in the auditorium and are connected to three different master switches, controlling the lights in groups. With this arrangement any desired combination is easily effected and the lighting arranged for any class of performance.

The bottom section of the middle right-hand panel is devoted entirely to d. c. control and the balance of the board to a. c. or d. c., depending upon which service is being used. Both sections are fed through three-pole switches, the d. c., single and the a. c. double throw so that in case of failure of the a. c., a limited amount of current can be taken from the d. c. feeders. All the switchboards were made by the Drendell Electric & Manufacturing Company of San Francisco.

The principal lighting of the auditorium is by means of a sunburst in the center of the dome. This fixture, which is intended to represent the sun, contains three hundred 16 c. p., frosted lamps. Above the lamps are gilded, metal rays, the whole combining to make a fixture of exceptional beauty and brilliancy, bringing out to the best advantage the architectural and decorative features of the interior.

The proscenium arch, where it would be shadowed by the light from the sunburst, is illuminated by a row of incandescent lamps concealed in the cove underneath. To further equalize the illumination of the gallery, balcony and orchestra, cove lighting is installed in the cornice at the rear of the gallery, at the rear and middle of the balcony and at the rear of the orchestra. This arrangement makes it possible to read the finest print with ease and at the same time entirely conceal the source of light from the eye when in a normal direction. One circuit from each group of cove lights is brought to a separate switch on the stage board so that it can be left in if desired when the house is darkened.

The proscenium boxes are lighted by specially designed fixtures, finished in gold and trimmed with multi-shaped crystal pendants, behind which are placed the incandescent bulbs. These fixtures are concealed to most of the audience by drapes suspended from the tops of the boxes.

The main foyer is lighted by three ceiling fixtures, the center supplied by five circuits and each of the others by two circuits. The balcony and gallery foyers are lighted by ceiling fixtures supplied from two circuits, one of which is the emergency and the other for general lighting, controlled by local push switches so that all but the emergency lights can be turned off during the performance.

The stairways and landings are lighted entirely by bracket fixtures, placed one at each landing and one midway of each flight of stairs. All of these lights are on the emergency circuits.

The facade is lighted by nine 250 watt tungsten lamps with Holophane reflectors concealed by specially designed hoods, located above the marquis and behind the front ornamentation. The marquise is lighted by 40 watt tungsten lamps spaced around the entire bottom edge and behind the glass decorative panels.

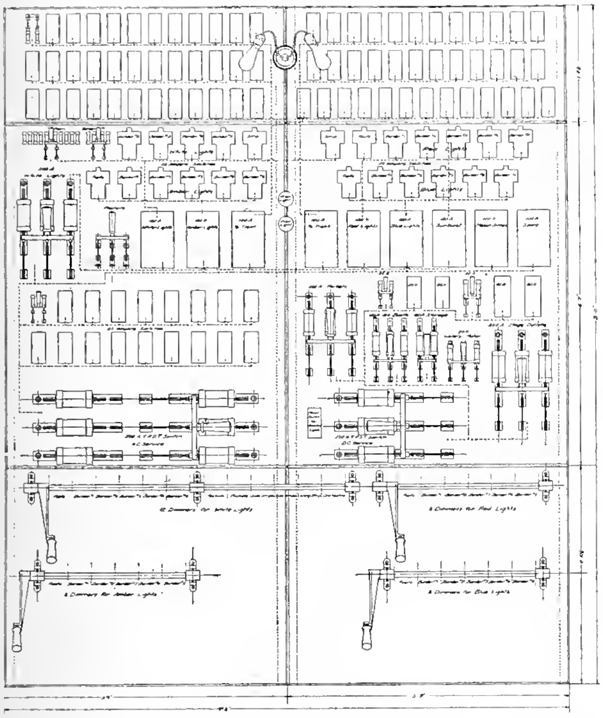
The stage lighting is laid out on the four-color scheme,—white, amber, red and blue. Each of the five borders have receptacles for 200 lights, 50 of each color. Each color is controlled by a separate switch on the board for each border, similar colors on all the borders and foots being controlled by a master switch. The foots extend the entire width of the arch and are fitted with 132 lights and controlled by individual and group color switches. The strip lights on either side of the arch are each fitted with 24 white lights only.

There are 39 pockets on the floor of the stage, 26 for incandescent and 13 for arc lighting, four on each side of the arch, above the stage, for arc lighting and one on the fly gallery for incandescent. All pocket circuits are fed from a fuse panel for each class, located to the rear and side of the main board and controlled by master switches on the stage board.

All lights in the dressing rooms, on the gridiron, fly gallery, property rooms, scene docks, under the

stage and auditorium in the attic and the carpenter shop are controlled from the stage board. Plug outlets are provided on each floor for a portable bunch light to be used in cleaning the auditorium. Orchestra lights are supplied from 40 plugs in the musicians' pit arranged in a row on the front of the stage about 18 inches above the floor.

The stage lights are under the control of a bank of "Simplicity" interlocking dimmers, made by the Cutler-Hammer Manufacturing Company of Milwaukee, Wis. The operating levers are mounted directly on the switchboard, within easy reach of the elec-



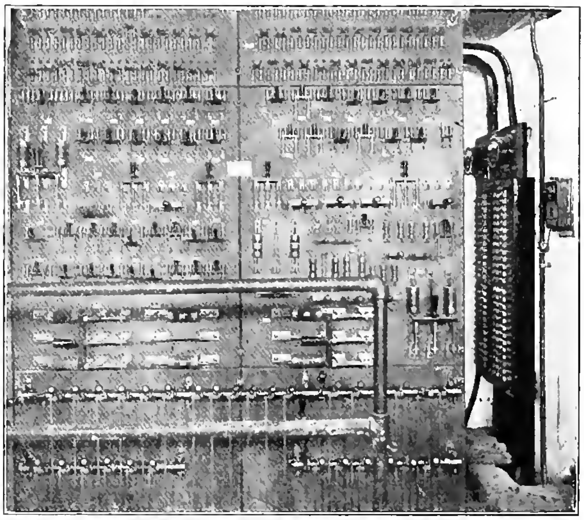
Switchboard Diagram.

trician, while the dimmer plates themselves are located beneath the stage, the connection to the levers being made by means of steel racks of suitable length. This arrangement leaves plenty of room behind the switchboard, an advantage too often lost sight of in theater installations. All of the parts above the stage floor are copper plated to conform to the general finish of the board.

The dimmers are arranged in four sections, one section controlling the white, one the red, one the blue, and the fourth the amber lights. The section for the whites contain 12 dimmers, while those for the other three colors contain six each, all dimmers being of approximately 50 lights capacity. Each dimmer has its own operating lever and the dimmers in each section are under the control of a separate master lever, by means of which any combination of lights in any section may be dimmed or brought up at will. They are mounted in two rows on an angle iron frame, located in a separate space where they are well ventilated and particularly accessible, and any one can be cleaned or overhauled without disturbing another. The dimmers control the lights as follows, each color on the borders and foots, each side strip, all of the incandescent pockets on either side of the stage, the pocket on the fly gallery for ceiling strip, and the orchestra lights. Master levers control the following groups, all white lights, all ambers, all reds and all blues. All white lights on the stage and in the auditorium are also controlled by one master switch.

In the power system there are five motors totaling 25 h. p., three of which are on the ventilating system, one on the pneumatic cleaning and one in the carpenter shop.

The storage battery consists of 60 Gould cells having a capacity of 80 amperes for one hour and installed in a ventilated compartment in the basement. They are charged from the 220 volt power circuit through a rheostat and combination over-and-underload and no-voltage circuit-breaker which automatically opens the circuit upon the completion of the charge. A voltmeter and ammeter on the stage board indicates the charging current and terminal voltage of



Main Switchboard, Columbia Theatre.

the cells. The circuit to the emergency lighting panel runs direct so that it cannot be opened or closed except by the automatic switch.

Two telephone systems are installed, one for the public service connecting the ticket and executive offices, ladies' dressing room, smoking room and balcony foyer through a local private exchange, and the other an intercommunicating Couch 10-station system connecting the working parts of the house with the manager's office. From the stage manager's position, call bells, speaking tubes and flash signals connect with the fly gallery, orchestra, musicians' room, smoking room, dressing rooms and under the stage.

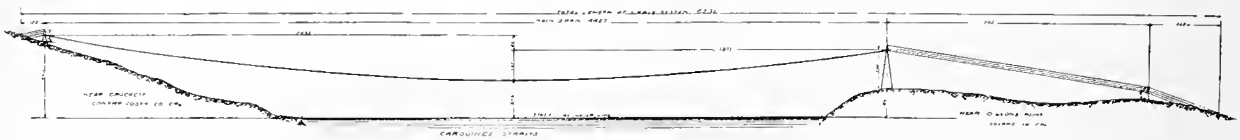
For the present the building is heated by steam furnished at 100 lb. pressure from the power plant of the St. Francis Hotel, one block east.

Every possible contingency and demand that could be thought of has been provided, the result being an installation thoroughly up to date in every respect. The electrical work was installed by the Decker Electrical Company under the plans, specifications and instructions of the architects for the theater, Messrs. Bliss & Faville, who have to their credit one of the most complete, substantial and beautiful theaters in the United States.

THE CARQUINEZ SPAN.[1]

The Straits of Carquinez is a comparatively narrow waterway separating Solano and Contra Costa counties, of California, and connecting San Pablo and Suisun Bays, which together form the northerly extremity of San Francisco Bay. At the point selected for the crossing the water is about 2750 feet wide with a depth ranging up to 120 feet, and through this narrow gap flow the waters of the Sacramento and San Joaquin Rivers as well as an ocean tide of about five feet, making at all times a heavy and dangerous current, which, though not so strong as to prevent the laying and operation of telegraph and telephone cables, is sufficiently so that it makes their maintenance a serious item and utterly precludes any possibility of laying and operating high tension power submarine cables. Of course the laying of such cables was considered very carefully, but the strength of the current in the channel together with the rocky character of its bottom and the impossibility of constructing heavy high tension cables that would operate at 60,000 volts and give assurance of withstanding the abrasion of the channel, soon led to the conviction that the only possibility of crossing the straits was to be found in the aerial method.

The 4427 ft. Span of the Pacific Gas & Electric Co. Across Carquinez Straits.



Profile of Span.

A survey of the conditions showed the waterway to be of the width and depth indicated, and that a bluff known as Dillon's Point existed on the north or Solano side of the straits, rising to a height of 162 feet above extreme high tide. On the south, or Eckley side, in Contra Costa county, exists a hill rising about 100 feet from the water's edge, whence it continues to rise in a general incline until, when perhaps half a mile back, an elevation of 400 feet has been reached. In front of this 100-foot bluff is the main line of the Southern Pacific railroad running from Port Costa to Oakland, along which, at Eckley, are numerous telegraph and telephone lines, a hotel, warehouse buildings and other houses constituting the settlement. Within a radius of a mile or so along the water front are the sugar refineries at Crockett, the smelters at Selby, and the enormous warehouses at Port Costa and vicinity which handle practically the entire grain output of the State for foreign shipment. Directly opposite, on the north side of the straits, where Dillon's Point is located, is found the southerly portion of Mare Island where the United States Navy Yard harbors the Pacific squadron. The Carquinez span reaches from the 400-foot elevation back of Eckley, across to Dillon's Point, passing directly over Eckley. The United States Government, in granting permission to cross at this point, stipulated that a clear headroom of at least 200 feet should be allowed for vessels.

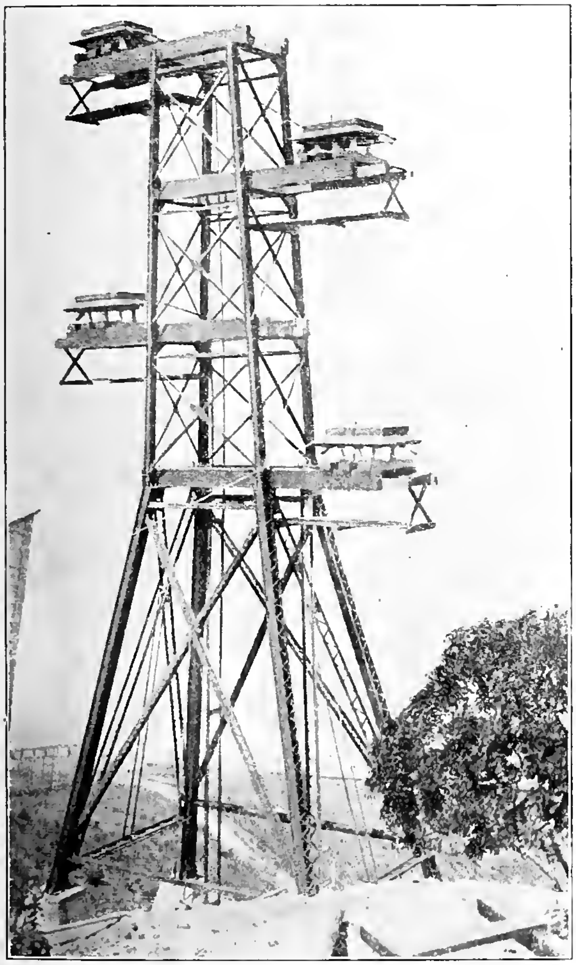
To meet all requirements it was finally decided to erect a steel tower 225 feet in height at a suitable position on Dillon's Point, and another steel tower 64 feet high back of Eckley on the south side at the 400-foot elevation referred to. These two towers are known as the "main" and "south" towers respectively, and the horizontal distance between their perpendiculars is 4427 feet. It must be borne in mind, in endeavoring to understand the reasons which led to the adoption of the plan followed in erecting the span, that a minimum clearance of 200 feet had to be provided above the surface of the water; hence, in order to limit the height of the main tower to 225 feet, as was advisable, it was decided to so locate the south tower on the hillside that its top should be 80 feet higher than the top of the main tower, thus throwing the lowest point of sag in the span off the lineal center between the two towers; in fact, this lowest point is 2455 feet from the south tower and 1972 feet from the main tower, as shown in the drawing presenting the profile of the crossing. A further reason for the arrangement adopted is found in the fact that the land north of the main tower falls away to a marsh at near tide level,

[1]Reprinted by request from the May and October, 1901, numbers of the Journal of Electricity, Power and Gas.

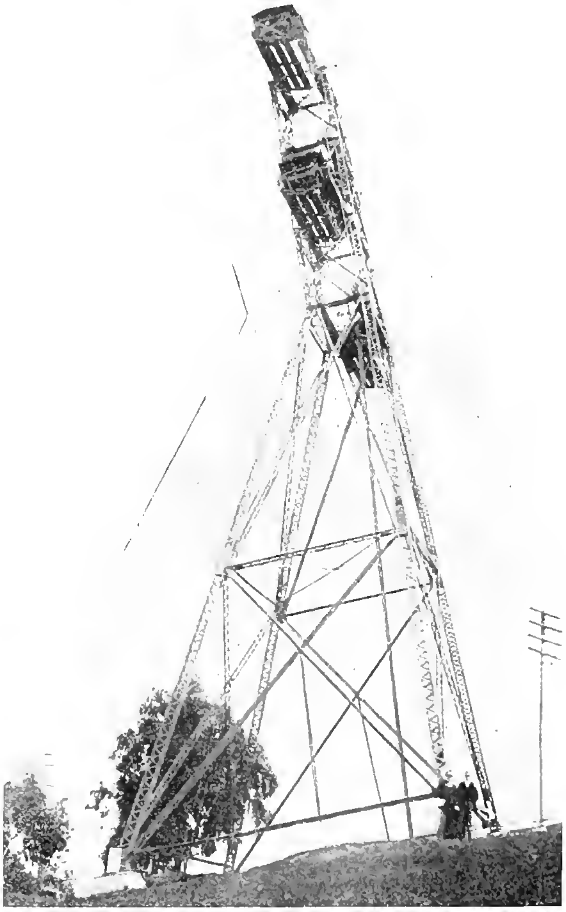
which made it necessary to turn the cables down to anchorages some 1700 feet back of the main tower. This condition compelled a great change in the dip of the cables between the main tower and the north anchorages, and necessitated the erection of the third or north tower, which, because of this change in direction of the cables, was built to lean toward the north. Its inclination is at an angle of 13 degrees from the perpendicular, and this has led to its being known as the "leaning" tower, although the company terms it the "north" tower.

On the other hand, the theoretical maximum tension strains amount in the aggregate to 9400 pounds, while the practical maximum allowed is 17,600 pounds, affording an ample factor of safety.

Twelve concrete piers with the corner ones arranged in a quadrangle measuring 69 feet by 89 feet between the pier centers, support the main tower, and these four main or corner piers are cubes of concrete having eight-foot sides. Bedrock is close to the surface on Dillon's Point, hence these piers are designed more to give weight as anchorages than to serve as foundations; or to express the idea in other words



The South Tower.



The Leaning or North Tower.

the concrete blocks are of greater utility for the weight they possess than for their serviceability as supports, although both are important. The two smaller towers are each supported on four piers, also of concrete, those of the south tower forming the corners of a quadrangle measuring 16x20 feet on the pier centers, while those of the leaning tower measure 31x28 feet on the pier centers.

The three towers are of steel and iron throughout with the exception of the main cross-arms supporting the cable saddles, which were of course designed to afford an insulating support for the cables. The principal interest in the strains and stresses to which these structures are subjected centers in the main tower, wherein compression and tension strains were thus determined: Assuming that the maximum pressure exerted by the wind will be 40 pounds per square inch, the maximum strains of compression upon each of the four corner posts of the main tower are:

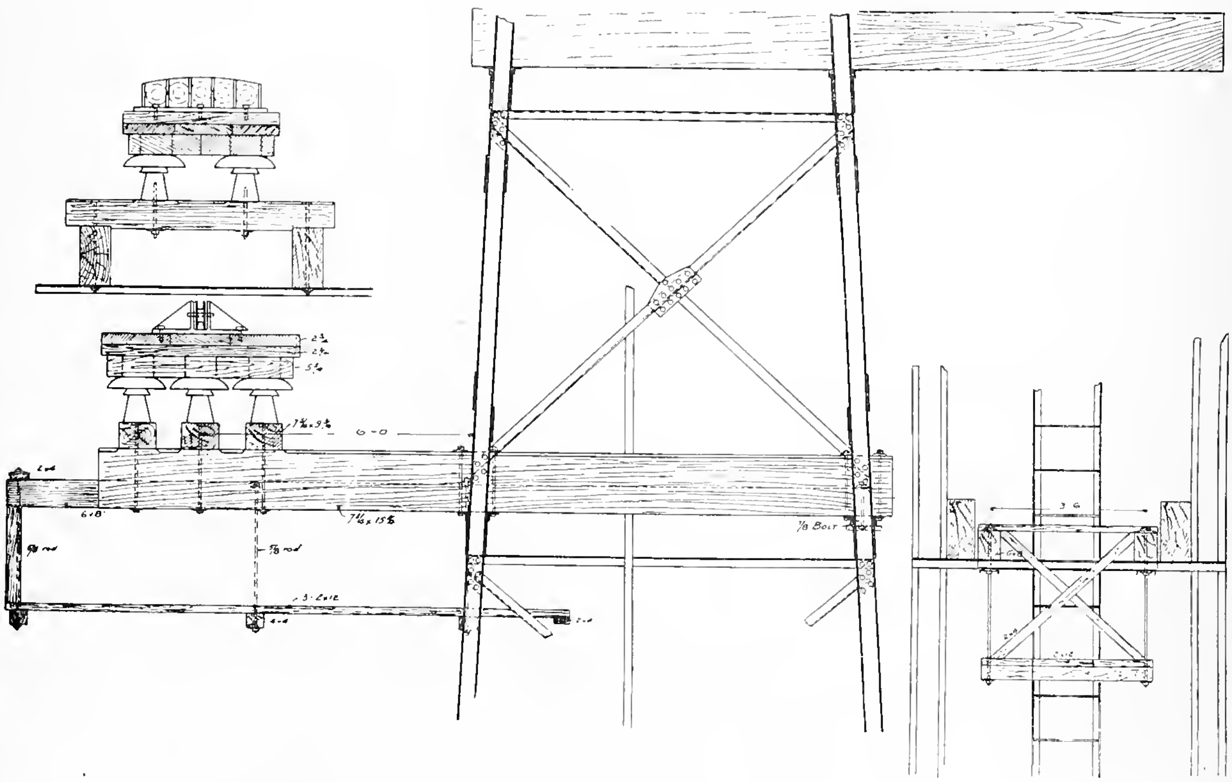
Wind strains	76,500 lbs.
Live load	6,000 "
Dead load	50,010 "
Maximum compression strains	132,510 lbs.

If the structures are viewed from their electrical standpoints, the greatest interest will be attached to the means for supporting the cables from the towers and for insulating them from their anchorages—for it must be borne in mind that the cables carry 60,000 volts. Beyond this, when it is remembered that each cable exerts a pull of twelve tons on its anchorages, the fact will at once be appreciated that the problem

of securing adequate insulation, coupled with sufficient mechanical strength, was by no means one of easy solution. The headwork, or cable supporting methods of the three towers, are identical in design, dimensions and materials. The timbers are of Oregon pine thoroughly kiln-dried, puttied and then given two coats of oil, after which they are covered with two coats of the best spar varnish. Two main cross-arms, each 17 feet 8 inches long by $7\frac{3}{4}$ inches thick by $15\frac{3}{4}$ inches deep, support three $7\frac{3}{4}$x$9\frac{3}{4}$x6-foot cross timbers upon each of which are mounted the two steel insulator pins that in turn carry the great porcelain Locke insulators that weigh approximately 50 pounds each, tested to 120,000 volts.

two courses each consisting of three $2\frac{3}{4}$-inch by 4-feet 6-inch planks. The whole upper platform is covered with the heaviest canvas and well painted with P & B paint, and wooden spouts, not shown in the drawing, are provided for carrying rainwater well away from the insulators.

The cable saddle is mounted directly upon this upper platform, being secured thereto by six bolts which do not go through the upper course of planking. These saddles are of galvanized cast-iron measuring 3 feet by 2 feet 2 inches, with an extreme height of 9 inches. A longitudinal channel 3 inches wide with walls each braced by six $\frac{5}{8}$-inch ribs, is cast into the saddle base, and in this channel are placed five cast-iron



DETAILS OF THE TOWER CROSS TIMBERS, CABLE INSULATORS AND SADDLE SHEAVES

Reverting to the drawing, the steel pins referred to above are not shown therein, although the bolts which enter up into the steel pin appear as penetrating the six-foot cross timber and entering the insulators. These pins stand 14 11-16 inches high above their cross-arms, their cone has a base of $5\frac{3}{8}$ inches in diameter, a height of 11 inches and a top of 2 inches in diameter, while the remaining 3 11/16 of the total height of the pin is cylindrical in shape, 2 inches in diameter, and cut with a standard thread to carry the great insulator. Steel bolts, 13 inches long by $1\frac{3}{8}$ inches in diameter hold the pins to their cross-arms, the bolts being drawn up by nuts placed under $4\frac{1}{2}$-inch washers and held by check-nuts. There are six insulators to each cable saddle, and the head of each insulator is countersunk into the timbers forming the upper platform—all these upper platform timbers, by the way, being boiled in paraffine. Above the countersunk timbers, which are two in number, each measuring 4 feet 2 inches by 1 foot 8 inches, are placed

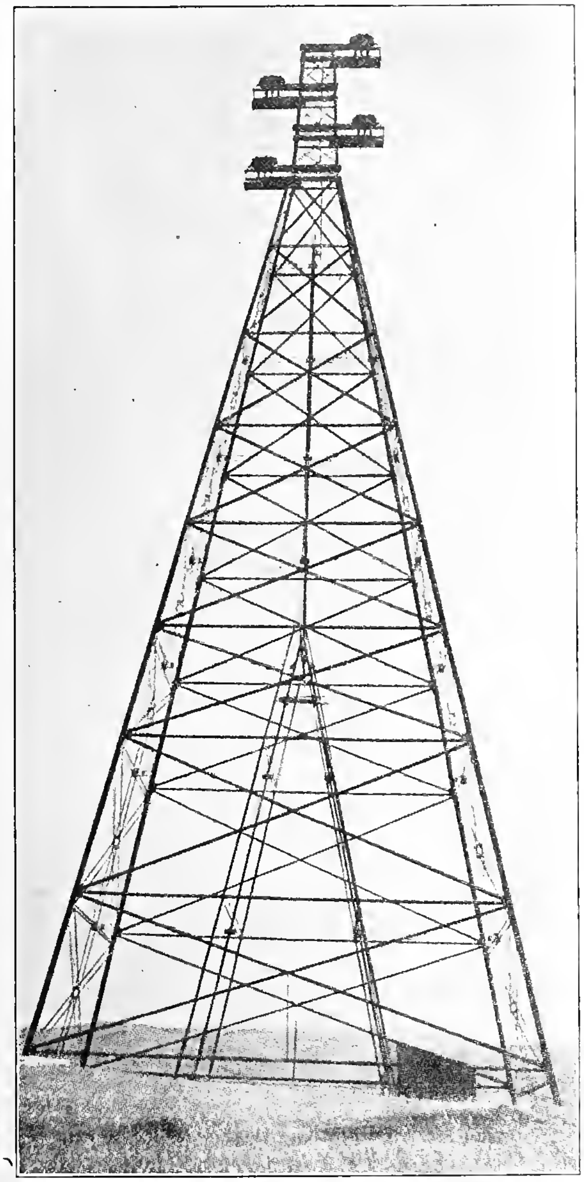
sheaves supported on 1 1/6-inch steel pinions the centers of which pinions are on an arc with an 8-foot radius. These sheaves have a diameter of $5\frac{7}{8}$ inches by an extreme width of 3 inches, and they are galvanized—as in fact are all cast-iron pieces exposed to the weather.

An extreme variation in temperature of 60 deg. F. may possibly occur at Carquinez, which would cause a variation of 5 feet in the sag and which in turn would cause a travel of approximately two inches to occur in the cables running over the sheaves of the main tower.

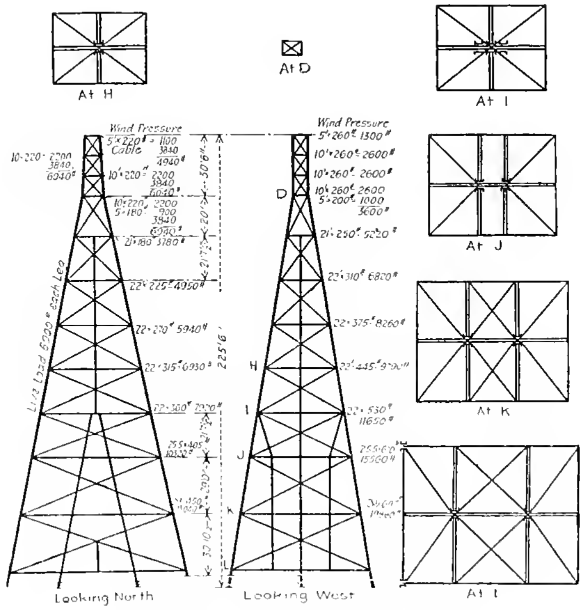
Individual anchorages, well separated, are provided for each cable, and they consist of masses of concrete, each having a base of 9 by 10 feet and being 5 feet high, set into the bedrock. Embedded in the concrete blocks are crossed channels and plates from which extend steel eyebolts with pin connections, first, to two sets of steel car springs, then a turnbuckle, then two tandem yokes connecting with heavy micanite insulators in copper cases containing trans-

former oil; and lastly, a 24-inch sheave around which the cable is turned and secured with clamps and clips.

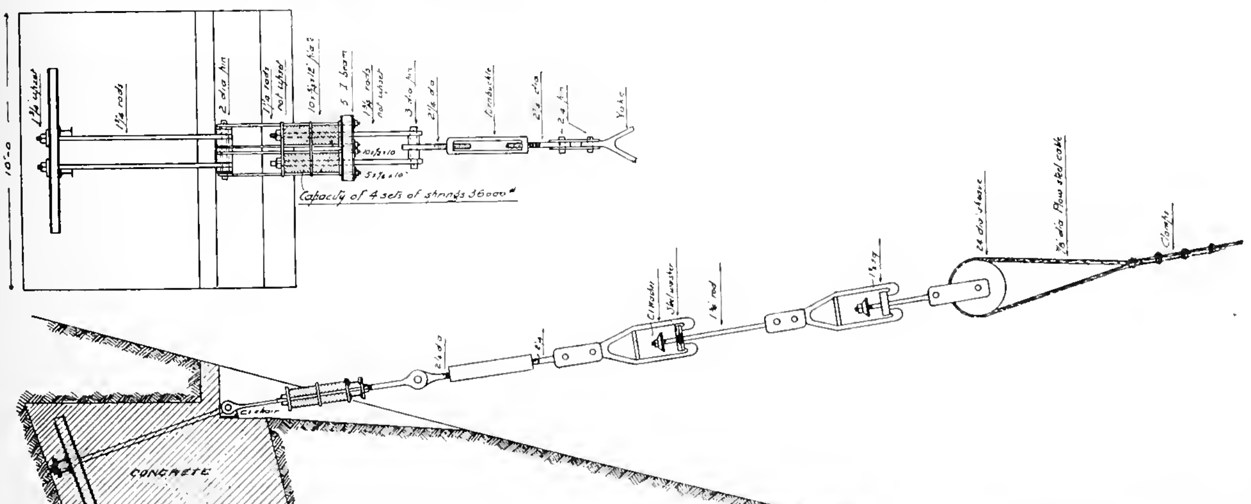
The cables consist of nineteen single-strand wires, weigh one and six-tenths pounds per lineal foot, and have a total breaking strength of 96,000 pounds, the unit breaking stress of the material being about 200,000 pounds per square inch. The wires had three coats of oil. Supporting nothing, but themselves, each cable takes the form of a catenary, which has a half-span of 1972 feet, and a deflection of 147 feet, measured from the main tower,. and a half-span of 2455 feet and a deflection of 227 feet, measured from the south tower. On this basis each cable would have a tensile load at the main tower of 21,840 pounds, and at the south tower of 22,000 pounds. Experiments were made of the effect of the wind pressure, and the conclusion was reached that it might, in extreme cases, double the calculated strains, and the cables were considered amply



Front View of Main Tower.



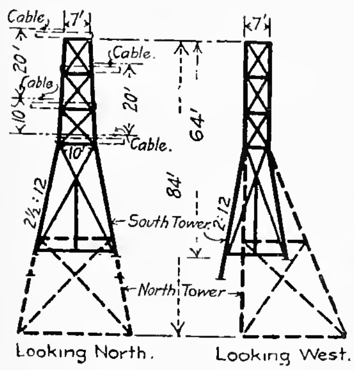
Stress Diagram of North Tower.

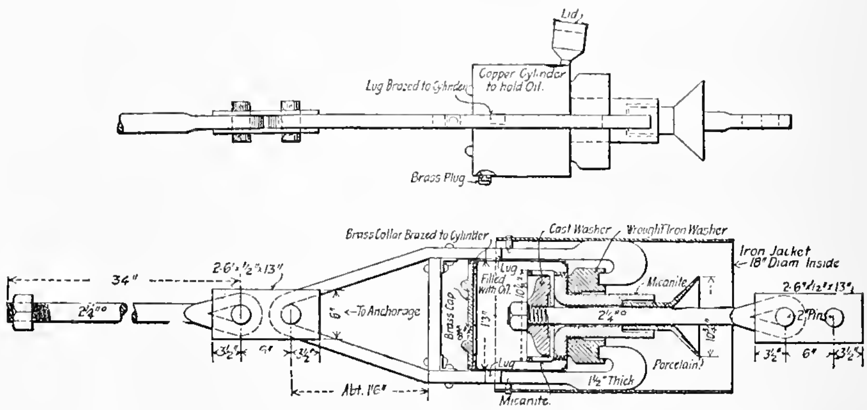


GENERAL DESIGNS OF CABLE ANCHORAGES AND CABLE CONNECTIONS.

safe for this. It has been found since that wind pressure will not strain the cables as much as assumed, as practically no shocks due to undulations will occur—simply a static pressure, due to a certain lateral deflection of the cables under heavy winds. It has been found that even in a gale the cables remain practically stationary at a certain lateral deflection, due to the wind, and that the wind does not produce undulations as had been expected.

The towers are of iron and steel throughout, except cross arms for carrying the cable saddles. The main tower is 225½ feet in extreme height from the foot of the lowest column, and has a base about 68x90 feet. The four main posts are each made of two 12-inch channels, battered in both directions, the center distances, of 9½x6½ feet at a point 30½ feet below the top, above which they batter in one direction only to a top width of 6½ feet both ways. The channels in the columns vary in size from 12-inch 30 pounds at the base (reinforced by one 5x3-inch angle in each lower section), where they sustain a maximum compression of 132,510 pounds in each column, to 5-inch horizontal and diagonal struts and be riveted to their flanges at intersections. The other vertical and inclined members in the lower stories of the tower are simply pairs of small suspension angles to support the centers of the long horizontal members. The main columns are spliced with flange and web plates just above the horizontal struts; all members were shipped separately and field riveted at intersections and connections. The main columns are anchored to crossed 4-inch I-beams in the bottom of the concrete blocks; the other columns are anchored with long bolts and washers built in the concrete. At every story the tower has ⅞-inch to 1⅛-inch horizontal lateral diagonal rods which are pin connected to angles riveted to the columns and to extensions of the tie plates on the horizontal struts. The members and connections of the bent tower are similar to those of the main tower, except that in the transverse face the struts are riveted to the column-web splice plates and elsewhere are riveted directly to the column channel webs without connection plates and that the lateral diagonals are single riveted angles. The columns are made of pairs

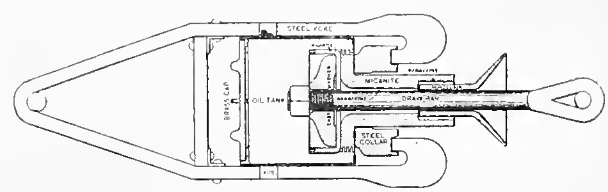




6¼ pounds at the top, where they have 5300 pounds compression in each column. The design was made to fit material on hand, as time was limited.

The pyramidal part of the tower is divided into stories from 20 feet high at the top to about 38 feet high at the bottom, braced with horizontal and diagonal struts in each face, as shown in the diagram. These struts are all made of four angles from 3x2 inches to 2x2 inches, pairs of them being latticed together with their flanges about 8 inches apart and their webs turned out from the center of the strut. Where these struts intersect, one of them is continuous and has a connection plate on each flange and the other one is cut to clear and riveted to each plate. These struts are connected to the columns by pairs of plates shop-riveted to the flanges and webs of the latter. On the opposite transverse faces of the tower and in a parallel vertical plane, midway between them, there is a pair of intermediate battered columns each composed of four 2x3-inch and 2x2-inch angles reaching to the fourth story, above which there is a single center column of four 2x2-inch angles reaching four stories higher. In each longitudinal face of the tower there is a similar center column seven stories high, and in all of them the two pairs of angles are latticed together with their flanges 8 inches apart, back to back, so as to pass through the of 8-inch channels, latticed, and the other members are each made of four 2x2-inch angles.

Micanite has been the salvation of the tandem strain insulators used to support the cables of the great Carquinez span, of the Bay Counties Power Company, for it combines great mechanical with dielectric strength. Unfortunately, however, micanite does not possess good surface insulation; that is to say, the shellac which is used to glue the layers of mica together oxidizes and offers a low creepage surface. This defect was overcome by combining with the micanite in this insulator the advantages of oil and porcelain, using the porcelain where mechanical strength was not required.



The detailed sectional drawing and photograph of the unassembled parts will best describe the arrangement of this insulator. The conical porcelain tube here shown gives ample surface insulation between the

drawbar and the steel collar corresponding to the difference of potential of the insulator, while the oil inside the copper tank acts in like service as well as to prevent arcing between opposite parts. The grooves shown on the flange of the micanite bushings are to increase the length of creepage surface, which, even in oil, is for this voltage not wholly to be relied on unless ample distance is given. The small cylinder or funnel on top of the tank is provided for filing it with oil and to inspect the oil level. While one of these strain insulators has sufficient insulation for the voltage used, it was deemed best to place two of them in series, so in case one gave out there would still remain a protection from grounding the cable.

It will, of course, be observed that no means are provided on the insulators themselves to prevent the interception of leakage to earth due to moisture on the surface, as in the case of the petticoat in line insulators. This, owing to the position in which the insulators are placed, makes such an arrangement impossible; therefore, a shelter was built over each set, and the entrance of the cable through the end of the house provided with a large window of plate glass with a hole 9 inches in diameter through which the cable passes.

PINCHOT'S SOLILOQUY.

Written for the Journal of Electricity, Power and Gas, with apologies to Shakespeare.

To conserve, or not to conserve, that is the question:
Whether 'tis better for the public to suffer
The grabbing of the coal lands and power sites,
Or for me to take arms against the Government,
And by opposing lose my position: To talk, to serve
No more; and by this talk to say we end
The danger and the thousand ills
That threaten? 'Tis conservation
For which we devoutly wish. To talk, to serve, aye there's the rub,
For in that talk of service what hopes may come,
When we have overcome this Ballinger,
Must give us pause. There's the respect
That makes calamity of so long life:
For who would bear the whips and scorns of Taft,
The monopolies' wrong, the subordinate's contumely,
The pangs of misjudged zeal, the law's delay,
The insolence of office and the oppression
That the power trust of its enemies takes,
When he himself might his quietus make,
By keeping still? Who would these fardels bear
To grunt and sweat and under a weary life,
But that the hope of something after Taft,
The political convention, from whose bourne
No politician returns, puzzles the will,
And makes us rather bear those ills we have,
In hopes of some day being President.

EXAMINATION FOR COMPUTER.

The United States Civil Service Commission announces an examination on February 16-17, 1910, to fill a vacancy in the position of computer, $1600 per annum, in the Coast and Geodetic Survey, for duty at Manila, Philippine Islands.

THE ATTITUDE OF INVESTORS TOWARD ELECTRICAL SECURITIES.[1]

BY GEORGE B. CALDWELL.

I might say that we meet today on common ground. You are students of electricity and electrical engineering and know better than I do the value commercially of the kilowatt, yet you will, I think, agree with me that if great plants are to be built, old ones rebuilt and the demands of the public satisfied, there is certainly one question more fundamental than that of technical means and methods.

That question is, "How shall the enterprise be financed?" It is there that you, representing the progressive ideas that you do, and the banker handling bonds meet on common ground, and ask the same question, "The Attitude of Investors Toward Electrical Securities."

I will mention a few of the elements that my experience suggests as essential to a marketable bond on an electrical plant.

First—It must not be overbonded, if the bonds are to be sold to the public.

Second—It must have good management.

Third—It must have a depreciation reserve, or sinking fund.

Fourth—Honest accounting.

The attitude of the investor is one seeking security first, income second, and convertibility finally. In this respect your securities are not different than those of other corporations. The difference, as I find it, is this: that electricity is regarded as an element that is less understood than most any other public utility. It is growing very fast in public favor for power and light, yet with this in its favor—backed as it is by a body of professional men—than whom there are none more progressive—the feeling exists that it has not yet been fully developed and that the methods employed for its production and distribution are rapidly changing.

I know investors who will purchase a gas bond who will not buy a bond on an electric plant alone. Their refusal is based, not alone on the plea that the character of apparatus required to produce electricity wears and deteriorates rapidly, but that it has not yet become standardized, thus making an additional risk—a double depreciation.

My own observation and experience is, however, that during the past five years you who are engaged in the science of electricity, as well as those engaged in the manufacture of electrical apparatus, have reached a state of perfection where standard apparatus, at least for light and power, is now to be had, and is so installed and operated as to be a safe business risk for a fifteen or twenty year bond. However, until the attitude of the public mind fully comprehends this, the marketability of electrical securities will be more or less affected by the reasons I have mentioned.

It is right here that you who are engaged in production, and the banker engaged in financing, should work hand in hand, to the end that tests as to the durability and productive power of all modern electrical plants should be clearly and conservatively determined, and the facts freely distributed, especially if securities are to be sold to the public.

[1]An address before the Electrical Club of Chicago.

As to a proper depreciation charge, I, of course, know that varies, and is a question of management or policy with the company itself. I am frank to say to you that until in very recent years this item has been very large—even larger than most operating men were willing to admit in their annual reports. As the operating end of electrical properties comes more and more to be handled by skilled electrical men, this item will grow to be less of a hazard, especially with standard machinery.

A man long connected with the General Electric Company recently assured me that with present day apparatus, where a property was kept up to a high state of efficiency, a depreciation charge of probably 5 per cent, at least 7 per cent, would keep the security good. If this is true, then electrical securities are not different from other industrial enterprises, and compare favorably with the depreciation account on a business block, even in downtown Chicago.

Put into actual practice, it means, however, that an electrical property costing today $250,000, must earn net above operating $25,000 annually to take care of a 5 per cent annual depreciation and pay 5 per cent on the money invested. Such an earning power does not, however, justify a bond issue for more than one-half of the investment, and then only where the franchise situation and management are the best and the public a ready consumer.

There is at least one other thing regarding marketability of electrical securities that is worthy of passing word. The census report of 1892 shows us that the average cost per electric plant was $140,000, while in 1907 it was $200,000—further, the eleven or twelve hundred million dollars invested in electric lighting and power plants is divided among some eight or ten thousand separate companies, with a net earning power of 14 per cent on capital invested.

We have here then a great number of small individual plants, unrelated in management or corporate organization. It is obvious that one must have a very specialized information to be a judge of the character of these innumerable different issues of bonds and stocks, and that the stocks in but a few instances pay dividends, while bond issues, even though conservative, lack in convertibility, which is but another word for marketability. In the main, such bonds bear 5 per cent and 6 per cent.

With the creation of larger corporations, operating conditions should likewise improve, and it is not at all improbable to say that within another five years capital control will itself consolidate many properties, and correct many operating evils, as well as broaden the market. I can illustrate my point no better than by my own experience.

Seldom a day passes but that the owner of a situation in a city of ten or twenty thousand people calls on me to purchase an issue of bonds for rehabilitation and extension of his plant.

Allowing that the margin of security is ample, the market is slow and doubtful, and if sold at all the discount is heavy. Such securities are either sold at home, or handled by small houses, or not at all, and are traded for apparatus and used at the smaller banks as collateral. In any case, it is a most expensive and unsatisfactory method of financing. Money secured in this manner frequently costs from 8 per cent to 10 per cent.

The remedy, so far as modern practice has offered one, comes from and through the large operating company. Here you find capital in control of one organization sufficient to handle many small situations economically and with it a management composed of the best legal and scientific operating talent. That this method is and will be the means of bringing confidence and a safer security to the hands of the investors is conclusive if the history and success attained by the existing holding companies are a criterion, for in every instance coming under my observation they have proven profitable alike to the stockholder and the bondholder.

Right here let me say that I am willing to concede that the business of manufacturing and selling of electrical energy has been almost uniformly profitable, yet it has been so after encountering many expensive obstacles both in engineering and financing. So much progress has been made that I regard a bond issue on a modern electric light plant in cities of fifty thousand and over as only an ordinary business hazard. For such hazard 5 per cent on a bond issue for not over one-half the cost, with a sinking fund provision that will retire the bonds in twenty years, makes a safe investment, providing net earnings power averages twice the interest.

There still exists, however, the questions of management and marketability. With these worked out, as they surely will be, the first by the aid of honest engineering and the last by honest financing—the investing public will have less cause of apprehension. Markets will broaden and prices improve.

In conclusion, I want to say I believe the utilization of our great water powers also tends towards a combined management covering large areas. It has indeed already worked great results in the matter of long distance transmission. Again, the public has pretty well learned that competition in such a field is not what is desired. The Public Utility Commissions, wherever they have become powerful factors in the control of electrical development, are inclined to take that same view and seek to obtain by regulation, rather than by competition, the fair treatment of the public. There is danger that at first Public Utility Commissions will undertake to assume all the functions of management, except the payment of interest and dividends. Just so far as this is done, just so far will initiative be deadened and development hampered.

Personally, I am not fearful of such a tendency. We are on the whole in favor of fair play and a very sensible people. We believe in business initiative. Intelligent management of properties, whether by a corporation acting with a commission, or without, already recognizes that it is the part of wisdom to give to their customers good service at reasonable cost. It is in the application of this principle, as well as in the use of the modern dynamo, for which you are responsible, that has made it possible for the electric business to double in five years. Given intelligent technical management, conservative accounting and a liberal interpretation of consumers' rights, and I see no reason why funds should not be found that will absorb all the securities of this character which it will be found necessary to create.

THE MELVILLE-MACALPINE REDUCTION GEAR.[1]

BY CHAS. F. SCOTT.

The most striking feature of the new spur-wheel reduction gear for high-speed steam turbines, which is attracting such wide attention, is its simplicity. There is no novel chain drive; no electrical nor hydraulic auxiliary. At first sight it is simply a common double helical gear of ordinary form. The supplemental element adds nothing to the principle of the gear, but is simply a means of overcoming the difficulties of the ordinary gear. The difficulty in a large gear does not lie in its ideal normal action, but in the impossibility of securing and maintaining the necessary mechanical perfections; hence, internal and abnormal forces result in friction, destructive wear or breakage. Obviously, if some device could provide a flexible or automatic adjustment which would do away with these internal stresses, a large high speed gear would be practicable. Apparently it was some such reasoning as this that led to a simple solution of the problem and produced the unexpected and almost incredible results which have been obtained. It is interesting to note that a gear with ten per cent loss was considered admissible, that the arrangement for testing the present gear had been made suitable for the measurement of a loss of about five per cent, and that these methods had to be modified when the loss was found to lie between one and two per cent.

So simple a thing as a large spur-wheel gear may not at first sight appear of unusual consequence or excite enthusiasm. There are, however, several notable conditions which are involved. The gear concerns the efficient generation of power in large units. The industrial and commercial progress of the past century has been dependent upon the generation of power and each new step in the means for producing and transmitting power has opened up new fields of activity.

The steam turbine has had two fields of application—the electric power house, where it has, in a few years, almost wholly superseded large reciprocating engines; and high speed vessels. In the latter the turbine has been run at an inefficient speed, and yet it is taking the place of the reciprocating engine; now, the more efficient turbine and gear are applicable to both high speed and low speed vessels.

In ocean traffic the sailing vessel began to be supplemented by the steam ship with a simple steam engine some eighty or ninety years ago. About 1865 the compound engine opened the way for a new class of ocean-going vessels. The triple expansion engine followed some twenty years later, giving new power capacity and enabling larger sizes of vessels and higher speeds to be attained. About ten years ago the turbine was first introduced for marine purposes, and soon came the Lusitania and the Mauretania. When the Great Eastern was built in the fifties, it was a practical failure because its machinery and its fuel took so much room that there was little left for cargo—although much smaller than the Lusitania, it required more than twice as much coal.

In this new gear the simple "floating frame," which allows the automatic alignment of the pinion shaft, has removed the old limits of size and weight and efficiency in the prime movers which have been the controlling factors in steam navigation. One of the most striking features of the presentation by Mr. Westinghouse is the summary of the indirect advantages in construction, economy and cargo capacity which are made possible in the design of vessels under the new conditions.

In the electric power station, the electric generator and the electric system transform the enormous power of the turbine, run at its most efficient speed, which is quite unsuited for direct application, and transmit and distribute the power in small units at moderate speeds for ordinary and varied service. On shipboard transmission and distribution are not required, and electric machinery would be cumbersome and heavy. The gear is the adjustable link which allows the turbine and the screw each to work at its own best speed. Each is free and unrestricted; the old limits are removed and a new era of possibilities appears in marine construction, where tens of millions of horsepower require annually tens of millions of tons of coal in the international commerce of the world. The reduction gear may be a factor in the conservation of natural resources. On land, the development of water-power saves the consumption of coal; on sea, fuel alone can be used, hence the only way to save coal is by higher efficiency in its use.

The reduction gear is, of course, suitable for other applications than those on shipboard. A promising field is the operation of large, slow-speed, direct-current generators by high-speed turbines, as the direct-current generator does not readily lend itself to high speeds in large sizes.

[1]The Electric Journal.

EFFECT OF ELECTRICAL TRANSMISSION.

The statement is frequently made that water powers have increased in value since it became possible to transmit power electrically. Charles T. Main, mill engineer and architect, Boston, Mass., points out in a recent paper that to be correct the statement should be modified. Since the introduction of electrical transmission many water powers which were before unavailable and valueless have been developed and become of value, and many others will be in the future, but water powers which have been developed and the power used adjacent thereto have, as a rule, not increased in value.

To the cost of the development must be added the cost of the electrical apparatus and pole line to a point where the power is to be used, and this is a large item of expense in long-distance transmission. Usually, also, there must be added to the cost of the physical part of the plant a considerable amount for right of way for pole line, legal expenses, and cost of financing.

To the running expenses must be added the fixed charges for the electrical apparatus and pole line, and the cost of running and maintaining the same. A correction must also be made for the loss of power in transmission.

A comparison of the cost of producing and transmitting power can be made with the prices which can be obtained for this power to determine if the development has any value, and whether the development is warranted or not.

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POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue*. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

FOUNDED 1887 AS THE

PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Electric lighting has come to play such an important part in theatrical productions that its absence would be more keenly felt than that of the leading man. The details of its application to the newest of the Pacific Coast theaters, the Columbia, cannot but be of interest, especially as described elsewhere in this issue by the engineer who designed the layout, Mr. W. W. Hanscom.

Engineering attention during the past week has been centered on the aviation meet at Los Angeles. Record flights have been made for both height and distance, but like the wireless records, these marks are no sooner set than they are eclipsed. At present the aviator is to be classed among sportsmen, as the commercial applications of the flying machine, except as a crowd-gatherer, are yet undeveloped.

As told in these columns last week, the great span of the Pacific Gas & Electric Company across the Carquinez Straits was recently the scene of an unfortunate death. Incidentally the resulting short circlit set fire to the wooden cross-arms and it was only after the most strenuous efforts that the span was saved from destruction. In consequence the article that we print this week has a news interest aside from its descriptive value.

A Cogent Analogy

In his recent message to Congress, President Taft has frankly recognized the corporation as being inevitable for the proper transaction of modern business. It would be well if every one else would as squarely acknowledge its necessary existence for the present and cease bewailing the passing of the old regime. It is far more profitable to adapt ourselves to conditions as they are than to attempt the quixotic task of changing them to others that may be more chaotic.

A great machine with its intermeshing gears is cognate to the mechanism of a great business, which is ceaselessly grinding out wealth by the aid of human cogs. It is impossible for every one to be a prime mover, and recognition of the fact that a machine is no stronger than its weakest cog should spur on the weaker ones. The breaking of a cog in a machine usually means but a temporary stop until another can be substituted, although occasionally it does much damage if it gets among the gears. Men of executive ability are the drivers; others the driven. Some of the more capable inter-mesh with so many, that they represent not one, but many cogs, constituting a complete gear in themselves. Success comes to those tactful men whose cogs easily slide into mesh with others when a change is made. Why not at least be an efficient cog?

PERSONALS.

R. B. Daggett returned to San Francisco from the East this week.

T. Hause, electrician of Napa State Hospital, visited San Fiancisco this week.

H. L. Hibbard, electrical engineer with the Cutler-Hamner Mfg. Company of Milwaukee, Wis., is in San Francisco.

T. C. Rylands, owner of the Sonoma Valley Company of Sonoma, has been spending aviation week in Los Angeles.

G. I. Kinney, manager of the San Francisco offices of the Fort Wayne Electric Co., left for the Northwest this week.

A. L. Valentine has been re-appointed superintendent of public utilities for the city of Seattle, to serve for the next three years.

Walter B. Gump, mechanical and electrical engineer, spent part of this week in San Francisco on his way from Tacoma to Los Angeles.

W. J. Davis, Jr., Pacific Coast electrical engineer for the General Electric Company, left this week for New York on a visit to the factory at Schenectady.

F. C. Finkle, consulting engineer, announces the removal of his office from rooms 230-231 I. W. Hellman Building, to 628½ South Spring street, Los Angeles, Cal.

A. M. Klingman and L. S. Twomey, illuminating engineers with the National Electric Lamp Association, are visiting the Pacific Coast, with headquarters in Oakland, Cal.

F. A. Richards has arrived in San Francisco from the East to assume the position of manager of the car department of the Pierson-Roeding & Company of San Francisco.

Alfred Kendall, manager of the Sydney, Australia, office of the General Electric Company passed through San Francisco this week on his way to the factory at Schenectady.

Thomas Mirk of Hunt, Mirk & Co., has returned from a trip to Southern California, where some important contracts are pending in the line of steam-driven power plants.

A. A. Rogers, manager of the Denver office of the Westinghouse Machine Company, and D. W. Belden, manager of the El Paso office of the same company are in San Francisco.

Frank H. Trumbull, for six years salesman with the Trumbull Electric Mfg. Co., is now associated with Samuel H. Taylor of the Electric Railway & Mfg. Supply Co. of San Francisco.

C. L. Anderson, formerly assistant foreman for the Oregon Electric Company, is now superintendent of the overhead construction for the Astoria Electric Company at Astoria, Oregon.

Chas. Fisk recently resigned as chief clerk of the San Francisco offices of the Western Electric Company to go to London, England, as assistant manager of the Western Electric Company, Limited.

F. J. Leonard, electrical engineer for Swift & Co. of Chicago, who has just finished up the large plant of the Union Meat Company in Portland, passed through San Francisco last week on his return trip.

G. A. Richardson, formerly with the Hougbton County Traction Company, Houghton, Mich., has been appointed assistant superintendent of transportation for the Seattle Electric Company, of Seattle, Wash.

C. W. Scott has resigned as manager of the San Francisco office of H. W. Johns-Manville Company, to become manager of the Asbestos Mfg. and Supply Company of San Francisco. Mr. Scott left for the East this week.

O. S. Wakeling, formerly with Baker & Hamilton of San Francisco and recently sales manager for the Caldwell Bros. Co. of Seattle, has opened offices with A. F. Blair as mining and mechanical engineers, in the Mutual Life Building, Seattle, Wash.

J. A. Lighthipe, electrical engineer, with the Edison Electric Company of Los Angeles, has returned to Southern California, after spending a week in San Francisco. While there he inspected the Southern Pacific Company's new electric railway power station in Alameda county and other new installations in the vicinity.

C. W. Hutton, electrical engineer, has become associated with Sanderson & Porter, and has taken charge of the construction of the new Bay Shore sub-station of the Sierra & San Francisco Power Company adjoining the Martin Station of the California Gas & Electric Corporation in the Visitacion Valley, south of San Francisco.

PORTLAND SECTION A. I. E. E.

The January meeting of the Portland Section A. I. E. E. was held in the Knights of Pythias Hall at Eleventh and Alder streets, Tuesday evening, January 18, 1910. The following papers were presented on industrial power subjects: F. F. Barbour, "Irrigation"; J. J. Brady, "Electric Drive in Car Shops"; C. C. Crawford, "Individual and Group Driven Machine Tools"; A. W. Cochran, "Printing Press"; R. F. Monges, "Mining Work"; L. Quimby, "Saw Mills"; C. B. Smith, "Electric Hoists and Cranes in Mining Work"; H. R. Wakeman, "Conditions of Motor Application on Large Lighting Systems"; E. A. West, "Electric Furnaces."

L. B. CRAMER, Secretary.

PACIFIC COAST ELECTRICAL EXPOSITION.

Work on the re-building of the new Coliseum being now under way, under contracts which call for its completion during the month of March, it has been decided to hold the Electrical Exposition about April 1st. The date for the opening of the Exposition will not be named until work on the building is further advanced.

The Chicago Exposition closes January 29th, and the committee has taken into consideration the time required for the transportation to the coast of exhibits shown a Chicago, a number of which will be transferred intact to this point. The fact that the new Coliseum Building will be opened by the Electrical Exposition will give opportunities for publicity of which we will take every advantage.

Exhibitors will be interested in knowing that both the "Electrical World" and "Electrical Review" have contracted for space and will have special Eastern representatives in charge, who will cover the entire exposition with elaborate reports, fully illustrated.

PACIFIC COAST ELECTRIC VEHICLE ASSOCIATION.

In view of the fact that the Pacific Coast Electrical Exposition is to be held in San Francisco early in April, 1910, the members of the Pacific Coast Electric Vehicle Association have decided to postpone their annual meeting to that time and place. Exhibits of electric vehicles will be made at the show by most of the prominent manufacturers and the list of papers to be read insures an interesting meeting.

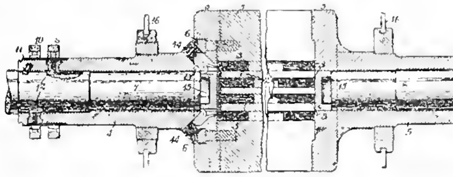
REMOVAL NOTICE.

The Portland Elevator Company recently moved to larger quarters at 5 to 7 First street, Portland. This company is now manufacturing its own controllers.

The San Francisco offices of the American Electric Fuse Company of Muskegon, Mich., will be moved from 121 Second street, to 143 Second street, on January 24. The new offices greatly increase the floor space and provides better facilities for handling the large stock which has been installed.

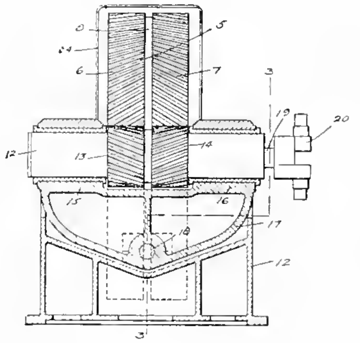
PATENTS

945,425. **Dynamo-Electric Machine.** Egbert M. Tingley, Pittsburg, Pa., assignor to Westinghouse Elec. & Mfg. Co. A rotatable member for dynamo-electric machines, comprising a magnetizable core having a magnetizing winding disposed in



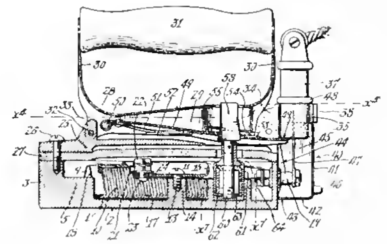
centrally located parallel and longitudinal planes, flanged coupling sleeves of non-magnetizable material clamped to the ends of the core, shaft sections the inner ends of which are seated in said coupling sleeves and soft metal blocks interposed between the ends of the shaft sections and the core.

946,456. **Reduction-Gearing.** George W. Melville and John H. Macalpine, Philadelphia, Pa. In reduction gearing, a gear, a pinion meshing therewith, a frame carrying said pinion and a pin for pivotally mounting said frame and provided with bearings on opposite sides of the plane including the axis of said



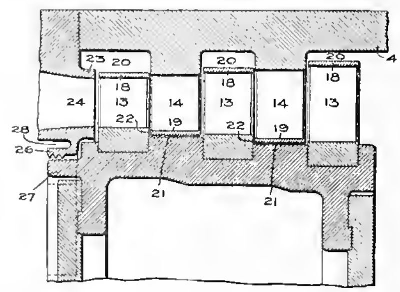
pinion and perpendicular to the plane including the axes of the gear and pinion so that said frame is capable of being swung by the tooth pressures during the operation of the gearing to permit of the automatic distribution of such pressures.

946,070. **Electric Laundry-Iron.** Earl H. Richardson, Ontario, Cal., assignor to Pacific Electric Heating Company, Ontario, Cal. In an electric laundry iron, a hollow body, a plu-



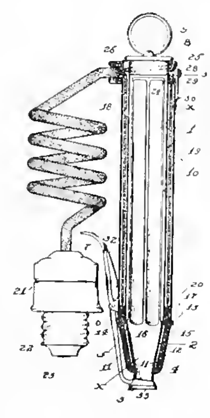
rality of electric heating units therein, means engaging the ends of the units for preventing their lateral movement in either direction, and a plate above the bottom of the body and detachably secured thereto, said heating units being interposed between said plate and the bottom of said body, whereby said plate exerts a vertical downward pressure on said units, holding them in close contact with the bottom of the body.

945,919. **Elastic-Fluid Turbine.** Charles G. Curtis, New York, N. Y., assignor to General Electric Company. In an elastic-fluid turbine, the combination of a rotor having rows of buckets, a stator also having rows of buckets located between those of the rotor, the rotor buckets acting to extract velocity from the motive fluid without substantial conversion of pressure into velocity while the stator buckets direct the fluid and



act to convert pressure into velocity, covers for the buckets, those of the stator being located in close proximity to the rotor and beyond the path of the fluid jet to provide a restricted clearance to reduce leakage while those of the rotor are widely separated from the casing and have an unrestricted clearance, a nozzle for discharging fluid against the first row of buckets, a casing for the turbine, and an exhaust conduit.

945,822. **Electrical Apparatus for Melting Sealing-Wax.** William T. Von Tillow, San Francisco, Cal. An electric sealing-wax melting apparatus consisting of a tube having a tapered end and a restricted opening; an exteriorly mounted pivoted gate adapted to close said opening; an outer casing



concentrically spaced from said tube; a heating device consisting of an electro-thermal resistance encompassing said tube adjacent the said restricted opening; an insulator for said resistance; suitable electric connections between said electro-thermal resistance and the source of energy; and a suitable switch interposed in the electric circuit.

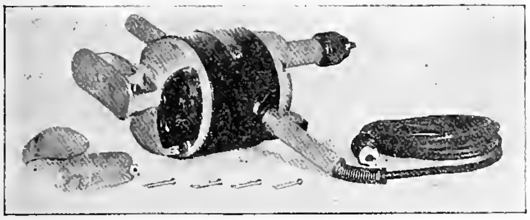
INDUSTRIAL

ALTERNATING CURRENT PORTABLE DRILL.

In the present day of skilled labor, high speed machinery, and plants of vast size, the minutes become a question of great moment. Fortunes have been made from the scrap heap, the profits of manufacturing plants have been enormously increased by the discovery of a method of turning waste into valuable by products. Will the moments wasted slip by unnoticed? Time is money. Profits depend upon the amount of business done. Economy of time must become a question of supreme importance to the large manufacturer or moments wasted will total an appalling amount.

The practice of taking heavy castings to a stationary drill, of spending much valuable time in adjusting them in order that a few brief moments may be spent in drilling is an instance of the wasteful methods that eat into the profits.

The direct current portable breast drill designed by the General Electric Company has met with great favor and has so satisfactorily demonstrated its ability to do the work for which it was designed that they are now manufacturing



Alternating Current Portable Drill with Cover Removed.

an alternating current one which possesses all the superior features of their direct current drill and permits the use of this device where alternating current only is available.

It possesses the ruggedness of design required to withstand the hard usage incidental to its service, yet its weight has been reduced to a minimum, being but 21 pounds, ensuring that the device may be handled by one person with great ease and rapidity. Two gnurled side handles and a breast plate provide ample means for holding it securely in any position.

An indicating control switch for starting and stopping the motor is located conveniently near the right handle so that it can be operated by the right hand without releasing the hold on the right handle. This feature makes control of the apparatus so simple that the whole attention may be given to the operation of the drill. Hand holes are provided which furnish a means of easy access to the commutator and brushes for inspection and repairs if necessary.

The drill is fitted with a jacob's chuck which will take drills up to and including ⅜-inch in diameter. An idea of the great saving of time made possible by its use may be gained from the following approximate data. It will drill a⅜-inch hole 1-inch deep in cast iron in 27 seconds; in machine steel in 95 seconds. It will also satisfactorily operate a ¾-inch wood bit.

Compare this with the time required to move heavy castings to a stationary drill, adjust them, drill one hole, adjust again, drill another, etc. In general a crane will be required necessitating the services of several men in addition to the one operating the drill. In many cases the same work could be done in a few minutes by one person with a portable drill. It is designed for operation on a 110 or 220 volt, 60 cycle circuit to which it is connected by screwing the attaching plug into a standard lamp socket.

THE THREE VOLTAGE RATING OF MAZDA LAMPS.

The Mazda incandescent lamp when operated at an efficiency of 1.25 w. p. c. has proven itself far more economical than either carbon, gem or tantalum lamps on all costs of energy above a few cents per kw. hour. There are some cases, however, in which the cost of energy per kw. hour is very low, perhaps a small fraction of a cent. In such cases a cheaper and less efficient lamp may show greater economy in operating expense than the Mazda lamp operated at 1.25 w. p. c. The somewhat higher renewal expense of the latter lamp at this efficiency may not be counterbalanced by even a great reduction in the amount of current used where the current is cheap. Since the Mazda incandescent lamp is inherently of higher efficiency and quality, the question of its economical application to any particular case merely depends upon its operation at the correct efficiency. In the case just cited, a small sacrifice in efficiency of the Mazda lamp could be made in order to reduce the renewal expense and thus secure greater economy than could be obtained with the other types of lamps even on very cheap power. Besides the actual saving in current made possible through the use of the Mazda lamp there is the very important possibility of releasing generating capacity, which even where the operating cost is low, may often be of great value. This point should not be overlooked in deciding the relative economy of high efficiency versus low efficiency lamps.

The incandescent lamp manufacturers have recently made a radical change in their methods of rating these lamps, in order that the lamps could be used with greater economy under those certain conditions, where heretofore their cost of operating exceeded that of a less efficient type of lamp and is most valuable in cases where the cost of electrical energy is low. The new method of rating called the "three voltage plan" is based upon the fact that for any given set of conditions, depending upon the cost of energy and cost of lamp, there is one particular efficiency and life at which it is most economical to operate a given lamp. Each Mazda lamp is labeled with three voltages two volts apart, as for example: 114, 112, 110, called top, middle and bottom voltage respectively.

This method of rating makes it possible for a customer to select the particular efficiency of lamp he wishes to use by specifying that either the top, middle or bottom voltage, as the case may be, should be the same as that of his lighting circuits.

When burned at top voltage the Mazda lamp has the highest efficiency or consumes the least energy for the light produced, and gives life of 1000 hours. At middle voltage more energy is consumed per candlepower produced and the life is lengthened (due to operation at a lower temperature) to 1300 hours. At bottom voltage the lamp is operating at lowest efficiency and gives a life of 1700 hours. It is obvious that the relative cost of lamp and energy will determine the most economical life and efficiency, since if energy is cheap the saving in energy obtained by operating the lamp at high efficiency is not sufficient to counterbalance the higher resulting renewal expense. On the other hand, if energy is relatively expensive, then it will be desirable to operate the lamp at a high efficiency, since the saving in current at the higher rate will more than pay for the increase in renewal expense.

The efficiency of the different sizes of lamps at top voltage is not the same, since the larger lamps are relatively longer lived than the smaller ones, and, in order to give all sizes a uniform life of 1000 hours at the top voltage, it was necessary to operate the 25 watt lamp at 1.33 watts per candle, the 40 watt lamp at 1.25 w. p. c., the 60, 100 and 150

watt lamps at 1.20 w. p. c. and the 250 watt lamp at 1.15 w. p. c. The advantage of the new plan will be apparent by referring to the Table No. 1 showing the cost of producing light with Mazda lamps. This table is based on list price of bowl frosted Mazdas, and shows the total cost of operating the several sizes at top, middle and bottom voltage with costs of energy from 1c to 20c per kw. hour. The total cost given in the table includes the cost of the energy consumed and the renewal expense involved in the production of a quantity of light equivalent to 100,000 lumen hours (which is equal to about 10,200 mean horizontal candle hours in the case of the Mazda lamp).

bottom voltage will then show economy for the Mazda lamps over either carbon, gem, or tantalum down to energy costs as low as 0.2c per kw. hour.

Table No. 2 shows the comparative cost of producing 100,000 lumen hours with carbon, gem, tantalum and Mazda lamps with costs of energy from 0.2c to 1c per kw. hour. This table is based on conservative total life values of the carbon and gem lamps in place of the usual useful life, since practically all lamps are left in service until ultimately burned out, rather than till they drop to 80 per cent of initial candlepower. The Mazda lamps have all been taken at bottom voltage, and the gem lamp has been figured in the same way as

Table Showing Total Cost of Producing Light with Tungsten Lamps at Top, Middle and Bottom Voltages oo Various Costs of Power

Nominal Watts	25			40			60			100			150			250		
Nominal C. P.	20			32			48			80			120			200		
Voltage	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom	Top	Middle	Bottom
Watts per candle	1.33	1.39	1.45	1.25	1.30	1.35	1.20	1.25	1.30	1.20	1.25	1.30	1.20	1.25	1.30	1.15	1.20	1.25
Actual watts	25.0	24.2	23.3	40.0	38.9	37.8	60.0	58.0	56.5	100	98.0	94.2	150	145.5	141.2	250	242.5	235
Actual c. p.	18.8	17.4	16.1	32.0	29.9	28.0	50.0	46.5	43.5	83.3	77.6	72.4	125	116.4	108.6	217.3	202.0	188.0
Total lumens	184.2	170.5	157.8	309.8	289.4	271.0	490.0	455.7	426.3	816	760	710	1225	1141	1064	2104	1954	1819
Lumens per watt	7.36	7.05	6.77	7.74	7.44	7.17	8.16	7.86	7.54	8.16	7.76	7.54	8.17	7.84	7.54	8.41	8.05	7.74
Hours life	1000	1300	1700	1000	1300	1700	1000	1300	1700	1000	1300	1700	1000	1300	1700	1000	1300	1700
Kwh. cons. per 1000 hrs.	25.0	24.2	23.3	40.0	38.9	37.8	60.0	58.0	56.5	100	98.0	94.2	150	145.5	141.2	250	242.5	235
Cost of frosted lmp	$0.75	$0.75	$0.75	$0.85	$0.85	$0.85	$1.17	$1.17	$1.17	$1.55	$1.55	$1.55	$2.25	$2.25	$2.25	$3.20	$3.20	$3.20
Lamp rnwl per 1000 hrs.	.75	.58	.44	.85	.65	.50	1.17	.90	.69	1.55	1.19	.91	2.25	1.73	1.32	3.20	2.46	1.88

Combined Cost of Power and Lamp Renewals per 100,000 Lumen Hours in Dollars

Variable Cost of Power Cents per K. W. H.	25 Top	25 Middle	25 Bottom	40 Top	40 Middle	40 Bottom	60 Top	60 Middle	60 Bottom	100 Top	100 Middle	100 Bottom	150 Top	150 Middle	150 Bottom	250 Top	250 Middle	250 Bottom
1.	$0.54	$0.48	$0.43	$0.40	$0.36	$0.32	$0.36	$0.32	$0.29	$0.31	$0.29	$0.26	$0.31	$0.28	$0.26	$0.27	$0.25	$0.23
2.	.68	.62	.57	.53	.49	.46	.48	.45	.43	.44	.41	.39	.43	.41	.39	.39	.37	.36
3.	.81	.76	.72	.66	.63	.60	.61	58	.56	.56	.54	.52	.55	.53	.52	.51	.50	.49
4.	.95	.90	.87	.79	.76	.74	.73	71	.69	.68	.67	.66	.67	.66	.65	.63	.62	.62
5.	1.09	1.04	1.02	.92	.90	.88	.85	83	.82	.80	.80	.79	.80	.79	.79	.76	.75	.75
6.	1.22	1.18	1.17	1.05	1.03	1.02	.97	.96	.96	.93	.93	.92	.91	.92	.92	.86	.87	.88
8.	1.49	1.47	1.46	1.31	1.30	1 30	1.22	1.22	1.22	1.17	1.19	1.19	1.16	1.17	1.19	1.10	1.12	1.14
10.	1.75	1.75	1.76	1.57	1.57	1.58	1.46	1.47	1.49	1.42	1.45	1.46	1.41	1.43	1.45	1.34	1.36	1.40
12.	2.03	2.04	2.05	1.82	1.84	1.86	1.71	1.72	1.75	1.66	1.70	1.72	1.65	1.68	1.72	1.58	1.62	1.65
16.	2.57	2.59	2.64	2.34	2.37	2.42	2.20	2.23	2.28	2.15	2.22	2.25	2.14	2.19	2.25	2.05	2.11	2.17
20.	3.12	3.16	3.28	2.86	2.91	2.97	2.69	2.74	2.81	2.64	2.73	2.78	2.63	2.70	2.88	2.53	2.61	2.69

Reduction factor—25—60—100—150 watt lamps=78 per cent.
40—250 watt lamps=77 per cent.

TABLE No. 1.

In order to see how the most economical efficiency varies with the cost of energy refer to Table No. 1 and consider, for example, the cost of producing 100,000 lumen hours with a 60 watt Mazda at the top, middle and bottom voltage with energy varying from 1c to 20c per kw. hour. With the 60 watt lamp and with energy at 1c per kw. hour, 100,000 lumen hours can be produced most cheaply if the lamp is operated at the bottom voltage. The difference between the cost at top and bottom voltage with this cost of energy being about 19 per cent. At 5c energy the bottom voltage is still the cheapest

this is the most economical voltage for such low costs of energy. The average candlepower and watts during the life values shown have been taken in every case rather than the initial values. This has been done because the Mazda lamp maintains its candlepower much better than the other types, which is a distinct advantage in its favor and should be considered in comparing it with other types of lamps. The costs of lamps taken in this table are those for clear lamps in standard package quantity.

For energy costs above 5c or 6c any percentage saving

Comparative Cost of 100,000 Lumen Hours, Carbon—Gem—Tantalum—Tungsten Lamps, with Energy Below 1 cent per K. W. H.

		Carbon		Gem	Tantalum	Tungsten					
Rating		16 c.p. 3.1 w. p.c.	16 c.p. 3.5 w. c.p.	20 c.p. Bot. Vltg.	20 c.p. 2 w. p. c. —d. c.	25 w.	40 w.	60 w. Bottom Voltage.	100 w.	150 w.	250 w.
Actual initial c. p.		16	16	167	20	16.1	28.0	43.5	72.4	108.6	188.0
Actual initial watts		49.6	56	47.3	40.0	23.3	37.8	56.5	94.2	141.2	235.0
Nominal w. p. c.		3.1	3.5	2.83	2.00	1.45	1.35	1.30	1.30	1.30	1.25
Hours life		800	1700	1450	1200	1700	1700	1700	1700	1700	1700
Average c. p. during life		13.20	13.06	14.00	21.66	16.46	28.30	42.60	71.50	107.2	179.7
Average watts during life		48.6	54.9	40.2	41.0	23.9	38.6	55.6	92.6	138.8	241.3
Reduction factor		82.5	82.5	82.5	79.0	78	77	78	78	78	77
Lumens		138	135	145	215	161	274	417	701	1051	1739
Cost of lamp std. pkg		$0.18	$0.18	$0.225	$0.405	$0.567	$0.648	$0.891	$1.175	$1.701	$2.430
COST OF POWER—CENTS PER K. W. H.	2c.	$0.238	$0.160	$0.162	$0.195	$0.237	$0.167	$0.152	$0.125	$0.122	$0.110
	3c.	.269	.200	.190	.214	.252	.181	.166	.138	.135	.124
	4c.	.303	.241	.218	.233	.266	.196	.179	.151	.148	.138
	5c.	.339	.282	.246	.253	.281	.210	.192	.165	.161	.152
	6c.	.374	.323	.273	.272	.296	.224	.206	.178	.175	.166
	8c.	.445	404	.329	.310	.326	.252	.232	.204	.201	.193
	10c.	.515	.485	.384	.348	.355	.280	.259	.231	.207	.221

TABLE No. 2

but is now only about 3 per cent cheaper than at top voltage. At 8c per kw. hour the top and middle voltages are as cheap as the bottom voltage and above 8c the top voltage is the most economical. Where the per cent saving possible to obtain by operation at bottom voltage is slight, as for example is the case just considered with energy above 5c per kw. hour, it is far better to use the lamps at top voltage and thus secure not only a better quality of light but more light from a lamp of given size as well.

The greatest benefit can be derived from the three voltage plan, however, on the low costs of energy, where operation at

that it is possible to obtain by operating the Mazda lamps at other than top voltage becomes so small as to be negligible in comparison with the better quality of light obtained at the higher voltage. Only in those cases where energy is very cheap should anything but top voltage be seriously considered. For ordinary use on central station circuits on the usual central station rates, top voltage should always be used. The prime object of the three voltage plan, as applied to Mazda lamps, was to widen the field of its commercial application by making it competitive with the cheaper and less efficient lamps on low cost of energy.

NEW INSTALLATIONS BY THE GENERAL ELECTRIC CO.

The General Electric Co., through their San Francisco and Seattle offices, have contracts for installing a number of interesting electrical equipments in mines. These include a 400 h. p. induction motor, 440 volts, to be installed at the South Eureka Mine, Sutter Creek, Cal., and a 2600 k. w. hydroelectric plant at Sheep Creek, Alaska, for the Alaska Treadwell Mining Co. This power is to be transmitted to the mines on Treadwell Island at 2300 volts through a submarine cable.

The General Electric Co. is also installing for the White Pass and Yukon Railway at Skagway, Alaska, two type AQB 100 k. w., 3600 r. p. m., 2300 volt, horizontal Curtis turbine generating sets with direct connected exciters and two water-driven units, 250 and 125 k. w., respectively. The generators are two phase, 60 cycle machines.

The Whatcom County Railway and Light Co., whose steam plant at Bellingham, Wash., was recently changed to oil-firing, is installing an additional 2000 k. w., 2500 k. v. a., 1800 r. p. m., 2300 volt horizontal Curtis steam turbine generating set supplied by the General Electric Co.

RECENT SALES OF THE CROCKER-WHEELER COMPANY.

Recent sales of the Crocker-Wheeler Company aggregate more than 5000 horsepower in direct current motors and approximately 2000 k. w. in direct current generators and 2000 k. v. a. in a. c. generators. Prominent among these sales is one to the Bethlehem Steel Company of South Bethlehem, Pa., calling for five compound wound interpole motors with a total output of 3600 h. p. Two of these machines have a capacity of 1000 h. p. each at a speed or 285 r. p. m. This company has also ordered 19 of the well known C-W mill motors with a compound capacity of nearly 800 h. p. These orders will be an addition to the present equipment at the Bethlehem Steel Company's works of 10,900 h. p. in C-W motors. Another order calls for one 1200 k. v. a. a. c. generator to be used for light and power in the plant of the Miami Copper Company, Globe, Ariz. This generator is to operate at 107 r. p. m. and furnish 25 cycle, 3-phase current at 6600 volts. Among the orders for alternating current apparatus is one for the plant of the Virginia Bridge & Iron Company, calling for two 200 k, v. a. 200 r. p. m., 60 cycle, 3-phase, 2300 volt synchronous motors. This concern has also ordered one 50 h. p. compound wound, 230 v. direct current motor. Other important sales are as follows:

Two 2300 volt, 60 cycle, 3-phase alternators with a combined capacity of 280 k. v. a. to be shipped to the Weston Electric Light Company, Weston, Mass.; one 600 k. v. a., 600 volt, 171 r. p. m., 3-phase alternator for the Landes, Frary & Clark Company, New Britain, Conn. A 1500 k. v. a. generator is at present being constructed for this company; one 250 k. w., 200 r. p. m., 550 volt generator for the Burton Powder Company, Quaker Falls, Pa.; two 250 volt d. c. generators with a total capacity of 200 k. w. for the Flannery Bolt Company, Bridgeville, Pa.; two 250 k. v. a., 60 cycle, 3-phase, 480 volt generators, sixteen 20 h. p., induction motors, three 50 k. v. a. 440/110 volt, 60 cycle transformers, one 35 k. w., 125 volt, d. c. generator, and one 25 k. w. motor generator set for the Textile Building Company of Clifton, N. J.; sixteen 500 volt d. c. motors with a total of 197 h. p. and one 90 k. w. generator to be shipped to the E. D. Jones & Sons Company, Pittsfield, Mass.

The Portland (Ore.) Railway, Light & Power Company is again increasing the capacity of its hydroelectric plant. It has recently placed an order with Allis-Chalmers Company for a 3750 k. w. water wheel type 11,000 volt, 60 cycle, 3-phase, 360 r. p. m. alternator. This will be of the same general design as the 2500 k. w., 11,000 volt, 33 cycle alternators already supplied by the same company, and will be semi-enclosed. A 50 k. w., 120 volt exciter will be direct connected to an extension of the alternator shaft.

APPROVED ELECTRICAL DEVICES

CONDUIT BOXES.

Pressed steel outlet boxes for use with rigid conduit, sherardized or enameled finish. Cat. Nos. 3-R, 3-RB, 4-C, 4-CB, 4-CE, 4-RF, 4-R, 4-RD, 4-RR, 4-RDD, 4-SC and 4-S. "Unilets." Cast iron and pressed steel boxes for use with rigid conduit, with steel or porcelain covers or with porcelain bushings in sides. Types 1-12 inclusive and 14. "No-Thread" Outlet Boxes. Pressed steel outlet boxes provided with an outlet coupling secured to the box which permits the box to be used with unthreaded conduit. Approved Jan. 3, 1910. Manufactured by

Appleton Electric Company, 212-214 N. Jefferson St., Chicago, Ill.

CONDUIT OUTLET BUSHINGS AND COUPLINGS.

"No-Thread" Outlet Coupling. A sherardized fitting for securing outlet boxes to unthreaded conduit. Approved Jan. 3, 1910. Manufactured by

Appleton Electric Company, 212-214 N. Jefferson St., Chicago, Ill.

FIXTURES.

"All-Ways" Portable Desk Fixture. A fixture provided with a device for adjusting the position of the lamp both horizontally and vertically. This is accomplished by means of a collapsible arm pivoted on the base of the fixture. The wiring is exposed and is carried along the arm through eyelets secured to the rivets used in assembling the arm. Approved Jan. 3, 1910. Manufactured by

American Electric Company, 6500 State St., Chicago, Ill.

RHEOSTATS.

All capacities, 125-500 V. Motor starters, CR-107 and CR-109 (Type SA). Motor starters with field control, CR-162 (Type SFA). Speed regulating, continuous duty, CR-151-154 incl. (Type RA.) Printing press control, CR-171 and 171-A (Type PB). Field rheostats, CR-174 (Type F). Field rheostats, sprocket driven, CR-178 (Type F). Field rheostats, electrically operated, CR-179 (Type F). Also CR-111, CR-163 and CR-155 to 158 incl. (Types SO, RO and SFO respectively), with overload release devices which are inoperative during process of starting motor. Approved only when other circuit breakers or fuses are installed in connection with them. See N. E. Code Rule 60-g. Approved Jan. 3, 1910. Manufactured by

Fort Wayne Electric Works, Fort Wayne, Ind. (G. E. Co., Mfrs.)

All capacities 125-500 V. Motor starters, CR-107 and CR-109 (Type SA). Motor starters with field control, CR-162 (Type SFA). Speed regulating, continuous duty, CR-151-154 incl. (Type RA). Printing press control, CR-171 and 171-A (Type PB). Field rheostats, CR-174 (Type F). Field rheostats, sprocket driven, CR-178 (Type F). Field rheostats, electrically operated, CR-179 (Type F). Also CR-111, CR-163 and CR-155 to 158 incl. (Types SO, RO and SFO respectively), with overload release devices which are inoperative during process of starting motor. Approved only when other circuit breakers or fuses are installed in connection with them. See N. E. Code Rule 60-g. Approved Jan. 3, 1910. Manufactured by

Sprague Electric Company, New York, N. Y. (G. E. Co., Mfrs.)

TRANSFORMERS.

Reppell Bell Ringing Transformer for use on 100-125 volt A. C. circuits. Open circuit voltage on secondary 7 volts. Approved only for ringing bells, or for similar signaling work and when primary is installed in accordance with Class C of the National Electrical Code; Jan. 3, 1910. Manufactured by

Reppell Electric Co., 7 West 31st St., Kansas City, Mo.

NEWS OF THE STATIONARY ENGINEERS

PREAMBLE.—This Association shall at no time be used for the furtherance of strikes, or for the purpose of interfering in any way between its members and their employers in regard to wages; recognizing the identity of interests between employer and employe, and not countenancing any project or enterprise that will interfere with perfect harmony between them.

Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the business of the Association, and at all times preference shall be given to the education of engineers, and to securing the enactment of engineers' license laws in order to prevent the destruction of life and property in the generation and transmission of steam as a motive power.

California.

No. 1. San Francisco, Thursday, 172 Golden Gate Ave. Pres., P. L. Ennor. Sec., Herman Noethig, 816 York St.

No. 2. Los Angeles. Friday, Eagles' Hall, 116½ E. Third St. Pres., J. F. Connell. Cor. Sec., W. T. W., Curl, 4103 Dalton Ave.

No. 3. San Francisco. Wednesday, Merchants' Exchange Bldg. Sec., David Thomas, 914 O'Farrell St.

No. 5. Santa Barbara. Geo. W. Stevens, 2417 Fletcher Ave., R. R. No. 2.

No. 6. San Jose. Wednesday. Pres., W. A. Wilson, Sec., Lea Davis, 350 N. 9th St.

No. 7. Fresno. Pres., A. G. Rose. Sec., E. F. Fitzgerald, Box 651.

No. 8. Stockton. Thursday, Masonic Hall. Sec., S. Bunch, 626 E. Channel St. Pres., H. Eberhard.

Oregon.

No. 1. Portland. Wednesday, J. D. Asher, Portland Hotel. Pres., B. W. Slocum.

No. 2. Salem. A. L. Brown, Box 166.

Washington.

No. 2. Tacoma. Friday, 913½ Tacoma Ave. Pres., Geo. E. Bowman. Sec., Thos. L. Keeley, 3727 Ferdinand St., N., Whitworth Sta.

No. 4. Spokane. Tuesday. Pres., Frank Teed. Sec., J. Thos. Greeley, 0601½ Cincinnati St.

No. 6. Seattle. Saturday, 1420 2d Ave. Pres., H. R. Leigh. Sec., J. C. Miller, 1600 Yesler Way.

Practical letters from engineers and news items of general interest are always welcome. Write your items regardless of style. Communications should be addressed to the Steam Engineering Editor.

SAN FRANCISCO NO. 1.

San Francisco No. 1, N. A. S. E., held a very interesting meeting on Thursday evening, January 13th. A committee of five was appointed to confer with a like committee of California No. 3, N. A. S. E., to arrange for a ball to be given this winter. The purpose of this ball is to enable the families of the members of the N. A. S. E. to become acquainted and also to bring before the public the fact that such an organization exists. After the close of the business session, an open meeting was called to order by President P. L. Ennor, who introduced Mr. F. R. Graff as the lecturer of the evening. The lecture consisted of the following subjects: The Shattuck flash boiler, rotary steam engine, "steel coat" process, and rotary gas and gasoline engine. The above subjects were listened to with much interest, and many questions were asked which proved very instructive.

CALIFORNIA NO. 2.

The new year has started with signs of a big increase in membership, we having about ten applications on file and more in sight. We had a total gain of 54 for 1909, but with the suspensions made at the last of the year it leaves us with 434 active members. Our educational committee headed by Bro. Geo. A. Reichard, keeps things on the move every meeting night and he always has something for the future in the way of a lecture to bring the members out. The Seventh Annual Convention committee is very busy at present getting ready for the meeting to be held here and if all their plans are carried out, it will be a time to be remembered by all attending.

N. A. S. E. CONVENTION.

The Seventh Annual Convention of the California State Association, National Association of Stationary Engineers, will be held in Los Angeles some time in the early summer, 1910, under the auspices of Los Angeles Association No. 2, composed of 450 of the best engineers of the city and we wish to place before the public and the visiting delegates from all parts of the State, an exhibit along mechanical and engineering lines, that has never been equaled.

We have the written indorsement of the Merchants and Manufacturers' Association and the Los Angeles Chamber of Commerce and the assurance from them that they will do all in their power to make our exhibit a success. We are confident that we can accomplish our aim, if we can have the support of the manufacturers and dealers in engineering and allied lines.

The convention was held this year in the city of San Francisco and to say the least it was the most successful one ever held by a State Association throughout the United States, by reason of the magnificent exhibit placed before the public by the manufacturers and dealers in machinery and engineers' supplies, under the auspices of the members of the two associations of that city and what San Francisco can do, so can Los Angeles.

We will continue the exhibit for one week, during which time the convention will be in session alternate days, thus giving the delegates and visitors and people of our city an opportunity of seeing what we produce and have in engineering and manufacturing lines.

FRED. J. FISHER,
Chairman Convention Committee.

W. T. W. CURL, Secretary.

PRACTICAL MECHANICS—PAPER NO. 4.

In order to intelligently understand the applications of the instantaneous center a complete case will be worked out. For this example, consider the mechanism shown in Fig. III.

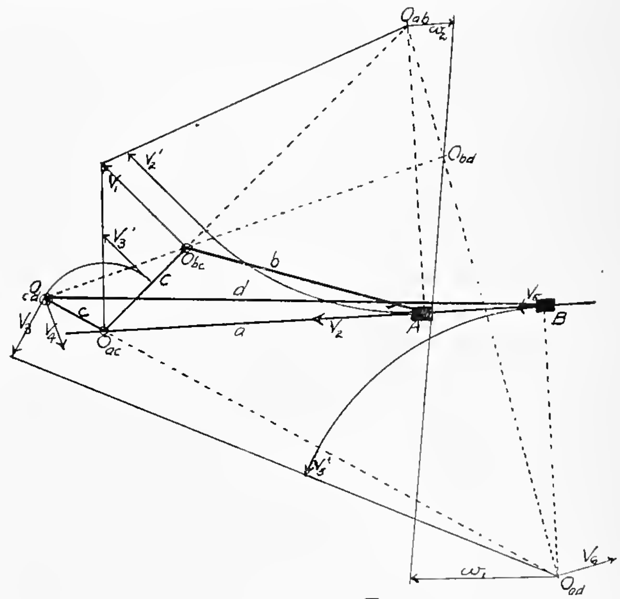


Figure 3

The train of parts in the diagram represent the crank, connecting rod, and eccentric rod gear of a simple slide valve engine. In referring to the various parts of this mechanism, and hereafter generally, we shall adopt the nomenclature used by Prof. J. N. Le Conte in his "Mechanics of Machinery." The two subscripts at each center indicate that the point so designated is the center for the two parts similarly lettered. Thus: O_{ac} is the center about which *c* is turning relatively to *a* or *a* relatively to *c*.

With a given number of parts a definite number of centers, either permanent or instantaneous, may always be found to exist. In Fig. III we are considering four independent parts, a, b, c and d, a being the engine frame, b the connecting rod, c the crank (and also the eccentric since there is no relative motion between these two parts), and d the eccentric rod. A denotes the center of the crosshead pin and B the center of the pin connecting the eccentric rod with the slide valve rod. For convenience we are considering the line of motion of A and B in the horizontal plane of the engine shaft, the center of which is O_{ac}.

The possible centers are obviously, O_{ab}, O_{ac}, O_{cd}, O_{bc}, O_{bd} and O_{cd}. Of these six centers, we can, by direct inspection, locate the permanent ones as follows: O_{ac}, O_{bc} and O_{cd}. Keeping in mind the law that the three centers for any three adjacent parts must all lie in the same straight line, we may proceed to determine the three remaining centers.

Proceeding as in Paper II, the center O_{ab} is found by erecting perpendiculars to the directions of motion of two known points of b. These two points are obviously the points of attachment of b to c and to a. The directions of motion of these two points with reference to a are shown by the arrows V_1 and V_2. The perpendiculars to these two directions intersect in the point O_{ab}, which is therefore the instantaneous center about which b is for the instant turning relatively to a.

Consider next the center O_{ad}. The two points of d whose motions with reference to a are known are O_{cd} and B. O_{cd} is turning in the direction shown by V_3, while B is moving in the direction V_2. Perpendiculars to these two directions intersect as seen at O_{ad}, the instantaneous center for a and d. We have now to determine O_{bd}.

We know that the center O_{cd}, which is a known point of d, is turning about b in a direction V_4 perpendicular to the line drawn through O_{cd}, O_{bc}, hence the required center will lie somewhere on this line. We know that at the instant under consideration center O_{ad} as a point of a is moving about O_{ab} in the direction V_6 perpendicular to the line joining O_{ab} and O_{ad}. But at this instant O_{ad} is also a point of d which is moving in common with a, since it is the center for these two parts. Therefore, the center O_{bd} must lie on the line O_{ab} O_{ad}, and hence at its intersection with the line O_{cd} O_{bc} as shown.

By applying the "three in a line" rule this center could have been found by inference; thus, b, c and d being adjacent parts, their respective centers must fall in the same line. Two of these centers O_{ad} and O_{bc} being already known, their line is established. Likewise a, b and d are adjacent parts, two of whose centers O_{ab} and O_{ad} are known. Hence the line joining them must pass through the third center. The point of intersection of those two lines is necessarily the only one that will satisfy all conditions.

By combining these two methods of analysis the complete determination of all the centers for any number of interconnected parts is possible.

We believe that if the foregoing solution has been carefully followed, the reader will have little difficulty in carrying out the analysis of such special cases as he may desire to investigate.

Determination of Relative Linear Velocity.

One of the most useful applications of the instantaneous center in machine design is in determining the velocity of any point when that of any other point in the train of parts is known. Suppose, for example, that we know the velocity, at any instant, of the crosshead of a simple engine and that we desire to find the velocity of the slide valve for the same instant. In Fig. III this may be stated thus: Knowing the velocity of A, find that of B. Let V_2 represent in direction and amount the known velocity of the crosshead A. Project this velocity on a circular arc to the line of c and call this V_2'. Through O_{ab} and the end of V_2' draw a line to cut the line V. This intersection will give the value of V_1, the linear velocity of O_{bc}, the crank pin. This deduction is based upon the fact that with a common angular velocity the circumferential, i. e., linear-velocities of two points in a rotating body are in the ratio of their respective radii. In the case in point all parts of b are for the instant in rotation about center O_{ab}; hence the velocity of O_{bc} is to velocity of A as their respective distances from O_{ab}. The construction taken is a simple geometric method of obtaining this ratio.. It depends upon the law that in similar triangles the bases bear the same ratio as the altitudes.

To proceed with the analysis, project the eccentric radius O_{cd} O_{ac} on a circular arc till it cuts the line connecting V_1 with O_{ac}, the shaft center. At this intersection draw V_3' parallel to V_1, and then lay off V_3 equal to V_1. V_3 is easily seen to be the circumferential velocity of the center of the eccentric. This value of V_3 is also the velocity of O_{cd} considered as a point of d turning about O_{ad}. Now, connect the end of V_3 with O_{ad}, project the radius O_{ad} B on to this line and draw V_5' parallel to V_3. Lay off V_5 at B equal to V_5' and by the same reasoning as before you have the required linear velocity of B.

This simple form of analysis with the use of similar triangles and the instantaneous centers is capable of many valuable applications to machine relations.

Determination of Relative Angular Velocity.

Relative angular velocities can be similarly determined by the use of the instantaneous center. Referring again to Fig. III we have given the angular velocity ω_1 of b about its center O_{ab} and are required to find ω_2, the angular velocity of d about its center O_{ad}. Lay off ω_1 from O_{ad} and draw through O_{bd}, the common center of the parts involved, a line till it cuts ω_1 drawn through O_{ab}. ω_2 as thus intersected will be the required value of the angular velocity of d about a. This may be proven by considering the center O_{bd}. As a point of b its angular velocity is ω_1, multiplied by its distance from O_{ab}. As a point of d its angular velocity is ω_2 multiplied by its distance from its center O_{ad}; but since O_{bd} is common to both b and d the ratio of $\frac{\omega_1}{\omega_2}$ must be as the ratio $\frac{O_{ad}\ O_{bd}}{O_{ab}\ O_{bd}}$

The construction above taken is seen to again involve two similar triangles, the bases of which are the two angular velocities. These are, by the law of triangles above stated, directly proportional to the adjacent sides, which sides are the distances respectively of the two centers from the common center. Prof. Le Conte sums this analysis up as follows:

"The relative instantaneous center of two moving bodies divides the distance between their centers in the inverse ratio of their angular velocities referred to a fixed body."

In practical machine design we rarely have to do with angular velocities about any other than the permanent centers. The analysis herein given is often useful, however, and should be thoroughly mastered.

TRADE NOTES.

B. Trenkman & Co., of Portland, have just completed a 13,000 gallon oil tank for the Multnomah Mohair Company's power plant at Sellwood.

R. B. Swayne, who has been in the pole and piling business in San Francisco for two years, has established a pole and piling yard in Oakland, where he will aim to carry a complete stock of the principal sizes in general use and of the best quality of Washington timber.

Smith, Emery & Co., inspecting and testing engineers, announce the following extensions in their iron and steel inspection department: Chief inspector, San Francisco office, W. F. Richards of Philadelphia; Los Angeles office, E. O. Slater and E. G. Harpham of San Francisco; Pueblo, Colo., office, M. L. Kulp of St. Louis; and Birmingham, Ala., office, R. T. Miller of San Francisco.

NEWS NOTES

FINANCIAL.

PLEASANTON, CAL.—An ordinance calling for an election February 8th authorizing $5000 worth of waterworks improvement bonds and $35,000 worth of sewer bonds was read for the first time.

SAN FRANCISCO, CAL.—The Hetch-Hetchy water bonds were carried by a vote of 32,876 to 1607. The Spring Valley bonds were lost by a vote of 22,059 to 11,724, or 1234 less than the necessary two-thirds majority.

POMEROY, WASH.—Mayor Howell has advised the Council to make arrangements for the issuance of city bonds for $16,500, for replacing the present wooden pipe leading from Butler Springs to Pomeroy with steel pipe.

DRAIN, ORE.—A special election will be held at the city hall January 22, 1910, to vote upon the issuance of $20,000 in bonds bearing a maximum interest of 5½ per cent, to run 30 years, $15,000 for a water system, and $5000 for sewers for this city.

BRAWLEY, CAL.—The City Trustees will receive sealed bids up to February 5th for $44,000 bonds voted December 28, 1909, for water works, etc. These bonds will be dated January 1, 1910 and bear 5½ per cent interest, payable semi-annually, and will mature in 20 years with privilege of prior payment.

MONTEREY, MEX.—Stockholders of the Guanajuato Power & Electric Company met in Colorado Springs, Colo., and voted to increase the capital from $3,500,000 to $5,000,000. The company is controlled by Henry Hine and L. E. Curtis, both of Colorado Springs. The company's extensive system at Guanajuato will be enlarged.

COTTAGE GROVE, ORE.—No bids have been received for the $100,000 5 per cent 25-year water bonds of the city, the trouble being that in the preparation of the ordinance calling for bids no provision was made for a sinking fund for the payment of principal and interest, other than by the levy of a tax in case the revenue from the system proved insufficient.

LOS ANGELES, CAL.—The William R. Staats Company is handling the Mt. Whitney Power & Electric Co., first mortgage six per cent gold bonds, dated October 1, 1909, due 1939. The Mount Whitney Power & Electric Company, owns and operates electric properties having a combined capacity from water power and steam plants of approximately 8,000 horsepower and serves with electricity for light and power, principally the latter, an extensive territory in the San Joaquin valley, including Tulare county, part of Kern county, and the cities and towns of Visalia, Tulare, Porterville and Lindsay. The net earnings as of October 31, 1909, were shown to be $172,322.38, or more than three and a half times the interest charge. The bonds now being offered, amounting to $350,000, are secured by a first lien on all property, rights, franchises and contracts.

LOS ANGELES, CAL.—The Pacific Light & Power Company has been reincorporated at $40,000,000, in order to make considerable enlargements and be prepared to meet the demands that will be made upon it. The incorporators are: H. E. Huntington, Howard E. Huntington, W. G. Kerckhoff, Caspar Cohn, George S. Patton and W. A. Kemp. No stock will be placed on the market, as the company has been fully financed, though bonds may be issued later. The Redondo plant is to be enlarged at once. It is proposed to spend $1,500,000 in adding three more units, making six units of 7,500 horsepower each. The sum already invested in the Redondo plant amounts to $1,750,000. More water power will be developed at Kern River. The company will run new lines, and build new plants in the mountains. It will also probably build new plants in the neighborhood of the city. The car lines are extending so rapidly, that the Pacific Light & Power Company, which furnishes the power, finds it necessary to prepare for the needs of the future. The Pacific Light & Power Company owns all the stock of the Ontario & San Antonio Heights Railway, the San Bernardino Gas & Electric Co., the Mentone Power Co., and the Riverside Power Co. It was incorporated March 6, 1902 and absorbed the San Gabriel Electric Co. The capital stock is owned by the Los Angeles Railway, and supplies power to the Los Angeles Railway, the Pacific Electric Railway, the Los Angeles Interurban, the Los Angeles & Redondo Railway Co., and does a general lighting and power business in Los Angeles and vicinity.

INCORPORATIONS.

WOODLAND, WASH.—Woodland Water & Power Company; $50,000; S. A. Burns et al.

TOPPENISH, WASH.—Submerged Power Wheel Company, $50,000; W. B. Campbell, et al.

ELBERTON, WASH.—Elberton Milling & Power Company; $60,000; Charles Hichliff, et al.

SANTA FE, N. M.—Rio Lucero Power Co. of Santa Fe, $100,000, by M. Martinez, B. G. Phillips and P. N. Black.

SEATTLE, WASH.—Granite Lighting & Power Company, of Seattle; $500,000; Harry M. Frost, James T. Hamilton, Cornelius Christopher, James H. Fox and Timothy J. O'Neil.

WHITE SALMON, WASH.—The Columbia River & Mount Adams Railroad Company has been incorporated with capital stock of $20,000,000, to build an electric railway from some point on the Columbia river in Klickitat county, northerly through parts of Klickitat, Yakima and Skamania counties, to a point in the vicinity of Mount Adams. The trustees are Adolph A. Suksdorf, E. H. Suksdorf, and Oswald N. Suksdorf, all of Spokane.

FRESNO, CAL.—The Fresno City, Belmont and Yosemite Railroad Company went out of existence last week, at a meeting of the stockholders held in the offices of A. G. Wishon. The company when originally formed secured the old franchise for a street railroad out on J street, Tuolumne and Blackstone to Belmont and out Belmont to Fresno avenue. This franchise was bought up by Griffith and McKenzie when they took up the traction work here.

TRANSMISSION.

NORTH YAKIMA, WASH.—E. F. Benson, head of the Prosser Power Company, announces that his company will proceed at once with the erection of its proposed 600 horsepower electric generating plant two miles below the city.

SAN BERNARDINO, CAL.—The Arrowhead Reservoir & Power Company, Victor Smith, general manager, San Bernardino, has purchased the Los Flores ranch on the Mojave River. The ranch comprises about 5000 acres, with valuable water rights.

OAKLAND, CAL.—At the last meeting of the Board of Supervisors the People's Electric Light & Power Company filed a revised application for a franshise for electric transmission lines through the county of Alameda, and for the conducting of electricity for furnishing heat and power. The changes in the previous application were made necessary by the annexation election.

CHIHUAHUA, MEX.—The Mexican Northern Power Company of Canada has been granted a concession to build two big dams on Conchas River, one of which will be at Boquilla, located about seventeen miles above Santa Rosalia and others at La Joya, farther up the Conchas. The Boquillo dam will impound enough water to develop 30,000 horsepower.

SAN JOSE, CAL.—The Sierra Light & Power Company has begun suit in the Superior Court of this county against the Spring Valley Water Company, to obtain a right of way for a transmission line in the vicinity of Dumbarton Point. The Suburban Company, the City and County of San Francisco and the Union Trust Company are also named as defendants in the suit. The Sierra Power Company has secured rights of way for 50-foot steel poles at a distance of 800 feet apart through Tuolumne, Calaveras, Stanislaus, San Joaquin, Alameda, Santa Clara, San Mateo and San Francisco counties. The only portion not yet secured by the corporation is a small strip of land near Dumbarton Point owned by the Spring Valley Water Company and subsidiary concerns.

SACRAMENTO, CAL.—Thirty thousand acres of land along the Stanislaus, Mokelumne and Yuba Rivers have been withdrawn from all forms of entry by the United States Department of the Interior. Information to that effect has been received by John C. Ing, Receiver of the United States Land Office in this city. The orders follow closely on a similar one affecting land along the North Fork of the Feather River, issued on December 19. The action, it is stated in the orders received by Receiver Ing, is temporary and will be in force pending legislation affecting the disposal of waterpower sites. The withdrawal along the Stanislaus River affects 4924 acres, of which 710 are entered. The land follows the meanderings of the Stanislaus River in fractional parts of the following townships: Township 3 north, range 14 east; township 2 north, range 14 east; township 2 north, range 13 east; township 1 north, range 13 east. Along the Mokelumne River 11,112 acres are withdrawn, of which 1400 are entered. The land lies along the Mokelumne River in fractional parts of various townships.

ILLUMINATION.

DRAIN, ORE.—An ordinance granting to the Drain Light & Power Company a franchise to light the city with electricity has been introduced in the Council.

ALAMEDA, CAL.—A contract has been signed with the Westinghouse Electric & Manufacturing Company to furnish the city of Alameda with transformers for the coming year.

GLENDALE, CAL.—Sealed bids are being received by the Trustees for furnishing the city f. o. b. cars, 5000 pounds No. 4 medium hard drawn triple braid weatherproof copper wire.

THE DALLES, ORE.—At its next monthly meeting the City Council will be asked to grant a franchise to J. D. Wilcox of Portland, who represents capitalists who desire to erect a gas plant in this city.

TACOMA, WASH.—The County Commissioners granted a franchise to the Tacoma Gas Company to construct a gas pipe line across and along certain roads from the city of Tacoma to the city of Puyallup.

CHEHALIS, WASH.—The Seymour Brewer Gas Company which will supply this city and Centralia with gas has secured a site in the north end of town 100x450 and will begin construction at an early date.

PORTLAND, ORE.—The Pacific Coast Engineering Company has been awarded the contract for putting in the foundation for a large power plant which will be erected on the river front at the foot of East Lincoln street by the Portland Railway, Light & Power Company. It will be necessary to drive 4000 piling for the foundation. A frame bulkhead will also be built to protect the piling.

SPOKANE, WASH.—The Board of Public Works is receiving sealed bids for three transformers with protection devices with all connections, in accordance with plans and specifications on file with the Board of Public Works.

RIVERSIDE, CAL.—The Board of Supervisors opened bids for a gas and electric light franchise for the town of Beaumont and the Beaumont Gas & Power Company were the only bidders. They bid $25 for the franchise and secured it.

LONG BEACH, CAL.—At the annual meeting of the Inner Harbor Gas Company it was decided to move the present plant on Alamitos avenue to the flat west of the city. The directors of the company are: D. M. Dobbins of Pasadena, F. W. Stearns, Thaddeus Lowe, etc.

TACOMA, WASH.—Sealed proposals are being received at the office of the Commissioner of Public Works for 1000 horsepower of electric current, on the peak load, for a period of eight months, commencing February 1, 1910, to be delivered at Station "C," South Tacoma.

SAN BERNARDINO, CAL.—San Bernardino and Colton are to be connected with a 3-inch high pressure gas main which will be used to convey gas from this city to Colton, three miles away. Later, when the central plant is built at Colton, the long main will be part of the distributing system from that source.

SEBASTOPOL, CAL.—John E. Bennett of San Francisco, president of the Russian River Light & Power Company, states that his company has awarded the contract for the construction of a high power electric line from Sebastopol extending north to the Russian River and thence down to Duncan's Mills, and from there south to Occidental.

VENICE, CAL.—General Manager W. A. Brackenridge, Assistant General Manager R. H. Ballard, and Electrical Engineer J. A. Lighthipe of the Southern California Edison Company, visited Venice and Playa del Rey recently to look at sites which have been offered by Abbott Kinney for the $5,000,000 steam generating plant, which the company contemplates erecting on the beach near Los Angeles.

STOCKTON, CAL.—The sinking of gas well No. 8 on El Dorado, near Channel street, will be commenced by the Stockton Gas & Electric Corporation at once and the work kept up until a heavy flow of gas is secured. It is now down 1789 feet and gas in small quantities has been encountered, but the company intends going much deeper unless a large quantity of gas is encountered. Well No. 9, in the northeastern part of the city, has been completed at a depth of 2630 feet with a 12-inch casing and a large quantity of gas is steadily flowing. The object in having the wells located in different sections of the city is to supply gas for cooking and heating and in those particular localities without it having to go through long mains. The new well has greatly increased the supply.

TRANSPORTATION.

MEDFORD, ORE.—The City Council has granted to John R. Allen a franchise to operate an electric road in this city.

LOS ANGELES, CAL.—The Los Angeles Pacific Railway will spend $6,000,000 in the construction of a subway and other improvements.

PORTLAND, ORE.—President Josselyn has started construction on three miles of the Cazadero division of the Oregon Water Power Company's line.

LOS ANGELES, CAL.—At a meeting of the directors of the Los Angeles-Pacific Railroad last week it was voted to issue bonds to the amount of $20,000,000, $10,000,000 of which will be used for improvements of roads and the other in paying old debts.

DAVENPORT, WASH.—The county commissioners have granted a franchise to the Washington Water Power Company for a spur line from Harrington to Odessa.

LOS ANGELES, CAL.—A bid of $100 by Robert Marsh and John Howes for a franchise for a street railroad on West Thirty-ninth street and Vermont avenue was not accepted by the Council.

VANCOUVER, B. C.—The B. C. Electric Railway is making preparations to construct at least 10 miles of railway in South Vancouver and Point Grey municipalities within the next five years.

SAN FRANCISCO, CAL.—The old Board of Supervisors voted not to grant the franchise of the "crosstown-Devisadero street" car line, applied for by G. R. Willcutt, acting for the United Railroads.

COLFAX, WASH.—A. M. Lupfer of the Inland Empire electric line is in the city looking after extending the road from this place toward Asotin and also announces that a line may be surveyed to Walla Walla.

ALAMEDA, CAL.—The Oakland Traction Company decided to improve its existing lines here for a party of surveyors were at work yesterday laying out lines for the broad gauging of the High street track.

FRESNO, CAL.—The ordinance providing for franchises on the west side for the Fresno Traction Company has been rejected by the Board of Trustees, and a resolution of intention to grant certain franchises passed to print.

THE DALLES, ORE.—Bids will be received until February 1st at the office of Newell, Gossett & Walsh, 32 Washington building, Portland, this city for the grading, tracklaying and bridging on the Portage railway from Eddy to The Dalles.

SEATTLE, WASH.—The City Council has passed an ordinance, granting to the Seattle Electric Company, a franchise to construct a street railway upon certain parts of Atlantic street and Utah street, and other streets, avenues and places in Seattle.

MONTESANO, WASH.—The Board of County Commissioners has been enjoined from granting a franchise to the Grays Harbor Interurban Company, applied for and granted at the December meeting for building electric lines on various roads of the county.

EUGENE, ORE.—The P. E. & F. Railway Company has agreed to build for a bonus of $35,000, several extensions to the city street railway system, including a loop of five miles in length out South Willamette street, past College Hill, then into the city again by way of Oregon avenue, and at the intersection of Eleventh and Willamette streets.

OAKLAND, CAL.—On account of the objection of W. R. Scott, assistant general manager of the Western division of the Southern Pacific Company, to the request of the railroad committee of the City Council that the company furnish and maintain street lights along the proposed right of way of the Peninsular Street Railway Company, the matter of finally recommending the granting of the franchise has been laid over until the next meeting of the committee.

CANBY, ORE.—The construction of an electric railway from Canby to Molalla is proposed and it is said that 20 miles of the line will be in operation by July 1st. Later the line will be extended to Portland, crossing the river at Canby, and going by way of the west side. Already an option has been placed on the steel to cover 16 miles, engine and 60 cars, formerly used on a logging railroad. This line, in no way, will interfere with the proposed Swift Railroad, as it will pass through a different section of the county, and through some of the finest timber land. The electricity for the proposed railroad will be supplied by the Canby Canal Company.

BAKER CITY, ORE.—The franchise to build a street railway system in Baker City, granted to Anthony Mohr, A. K. Bentle and T. B. Neuhasen last summer, and which expires this month, has been renewed and six months' time given for the franchise owners to begin work. The contract for the ties for the 45 miles of road to be built has been let according to Anthony Mohr, promoter of the proposed line. Orders for heavy gasoline cars will be placed for delivery in April or May, by which time it is hoped to have lines ready for operation.

WATERWORKS.

DIXON, CAL.—Bids will be received up to March 1st for a franchise to erect waterworks here.

MONROVIA, CAL.—The City Trustees will ask for bids at the next Council meeting for cast iron pipe to be laid in various streets.

PORTLAND, ORE.—The water board has awarded to the Montague O'Reilly Company a contract to lay a main to Twelfth street, between Marshall and Pettygrove streets for $2300.

FARMINGTON, N. M.—The town board has by unanimous vote decided to call an election to vote on a $25,000 bond issue to construct a municipal water system to supply the town with water from San Juan river.

TACOMA, WASH.—The City Council has passed an ordinance proposing to the voters that the city of Tacoma construct, as an addition to its existing water system a gravity water system from Green river in King county, Washington.

OAKLAND, CAL.—The Board of Public Works has accepted the pipe system of the recently completed salt-water fire-fighting plant from the contractors, Cotton Bros. The pumping plant, situated at "The Willows," on the shores of Lake Merritt, was subjected to a ten-hour official test, which proved satisfactory.

SANTA BARBARA, CAL.—The City Clerk will receive sealed bids up to February 17th for a pipe line franchise from the Potter hotel railroad spur track on city block 271, along Montecito street, to Castillo street, and along Castillo to the east corner of city block 309½. The Santa Barbara Gas & Electric Company has applied for such a franchise.

TACOMA, WASH.—The City Council has passed an ordinance calling for the laying of twelve-inch, ten-inch and eight-inch water mains, together with the necessary hydrants and connections with the present water main in Local Improvement District No. 549, and providing for the issuance of local improvement bonds to cover the cost.

REDONDO, CAL.—The Board of Trustees will receive sealed bids up to January 24th for furnishing and installing an auxiliary pumping plant consisting of a centrifugal or turbine series horizontal pump with a working pressure equal to 200 feet, including suction and friction and to have a capacity of 520 g. p. m. when working against head above specified; a 3-phase induction motor to operate on 2080 volts and to form a direct connected unit; and a marble switchboard.

COLUSA, CAL.—At an adjourned meeting of the Trustees last week the Board, after the consideration of some fifteen combination bids, as well as bids on the plant as a whole, let the contract for the new waterworks and distributing system, the contract price for the same being $47,935. The successful bidders were: Standard Engineering Company of San Francisco, represented by C. F. Braun, for the distributing system, wells, etc., for $31,857.10; and F. C. Roberts Co., of San Francisco for pumping station, tank and tower for $16,078.

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POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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POWER DEVELOPMENT OF THE CLACKAMAS RIVER

There are few western rivers whose potential power is to be more fully developed than that of the Clackamas, near Portland, Oregon. The Portland Railway, Light & Power Company, in its completed and intended developments that include three plants located along a ten mile stretch of the river, will soon be generating between 50,000 and 60,000 kilowatt of hydroelectric power. These include the present plant at Cazadero, the contemplated 30,000 k. w. plant on the upper Clackamas, several miles above Cazadero, and the 12,000 k. w. power site at Estacada, two miles below, which was recently purchased from F. S. Morris of the Portland Water Power & Electric Transmission Company. These do not take into account the 5730 kilowatt hydroelectric plant at Oregon City, nor the steam auxiliary plants in Portland.

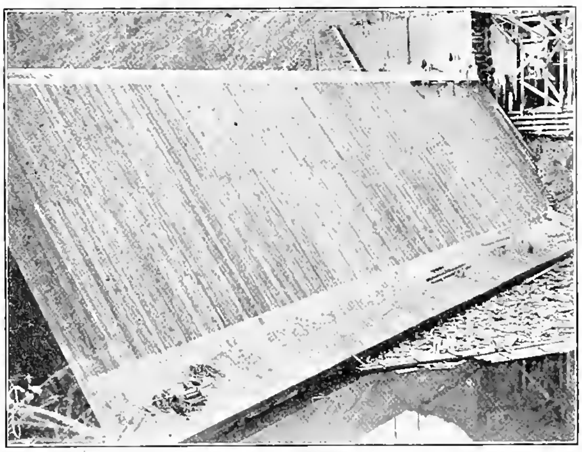
Site for 80-ft. Dam at Mill Bridge, near Estacada.

The Cazadero power house, a well lighted, reinforced concrete structure, stands on the western bank

of the Clackamas River, across which cables carry the current to step-up transformers. The equipment includes three 5000 h. p., 42-in. Victor turbines, direct connected to three 2500 k. w. a. c. generators, and a 5500 h. p. Victor turbine direct connected by one shaft to four generators; three 1000 k. w. and one 500 k. w. machines, connected in parallel on one bus. The efficiency tests of this arrangement have proven eminently satisfactory. In addition a 6300 h. p. turbine, driving a 3750 k. w. Allis-Chalmers generator, is to be installed this year.

Water for the Cazadero plant is supplied under a head of 125 feet by means of a diverting dam, one and three-fourths miles above the power house. This dam is constructed of rock and clay-filled log crib-work, plank-covered and strongly reinforced and bulkheaded. The top of the water spillway is 51 feet above low water.

Three miles above Cazadero, where the Clackamas gorge narrows at a favorable site, a great masonry

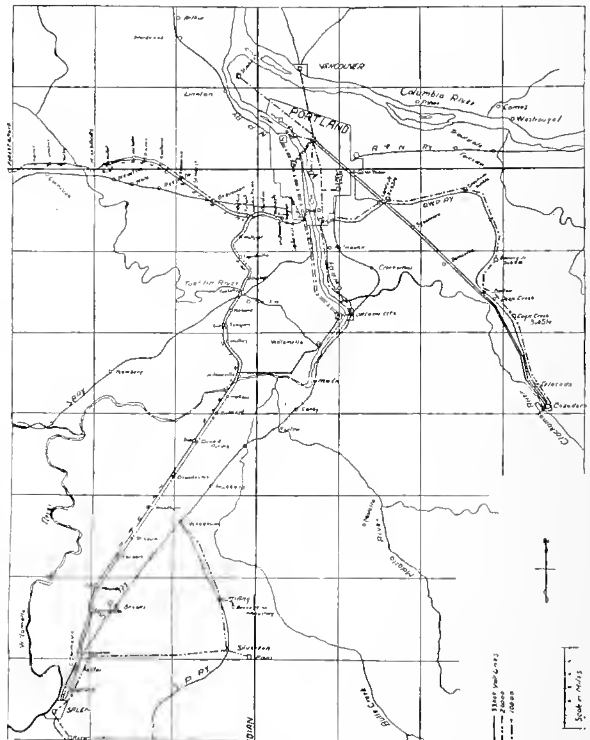


Spillway of Cazadero Dam.

dam, 155 feet high and 750 feet long is to be constructed, the contract having been let to Sellers & Rippey. The ground has been thoroughly tested by drill holes, and the earth sluiced down to bed rock. This will give a head of over 150 feet to the entire volume of the Clackamas river, which is to be first utilized in a 30,000 k. w. plant at the foot of the dam. This, it is hoped, will be completed by September, 1913. This dam will also regulate the flow for the Cazadero plant and for the new plant below Estacada, whose 12,000 k. w. is expected to be available by September, 1911, when a new 80 ft. dam will be completed.

Two 100,000 volt steel tower transmission lines are to be built between Cazadero and Portland, the present voltage over the existing wood and pole lines being 33,000.

In addition to the steam auxiliaries at Station E and F in the city of Portland, generating 6750 and 1300 k. w. respectively, a new plant is now being erected just north of Station F on the east side of the river. The construction of this plant involves the driving of 4000 piles as a foundation and the building of an enclosing cement bulk-head. Steam is to be supplied by eight Babcock and Wilcox boilers, aggregating 3520 h. p. and arranged in four batteries of two each. These will be equipped for automatic firing with sawdust, and also for fuel oil. The prime movers include one 34 x 68 x 54 heavy duty Hoover, Owens & Reutschel cross compound engine direct connected to a 2000 k. w. d. c. generator 90 r. p. m. 20 pole, 575-625 volts for street railway service and two 2000 k. w. Curtis turbo-generator sets, furnishing 60 cycle current at 2300 volts. This plant is to be at central station for the company's whole system.



Map of High Tension Transmission Lines of the Portland Railway, Light and Power Co. and Oregon Electric Co.

On February 1, the Portland Railway, Light & Power Company will occupy its newly completed nine-story office building at Seventh and Alder streets. The company has about completed its under-ground distribution system in the business section of Portland which was started last spring.

MORE LAND WITHDRAWALS.

In the aid of proposed legislation affecting the disposition of public lands thought to be valuable for power purposes, the Interior Department has withdrawn the following areas: Territory aggregating 17,332 acres along the Clearwater river and its tributaries in Idaho, 2549 acres along the Walla Walla river in Oregon and 24,152 acres along the Sevier river in Utah. As probably containing oil, 147,887 acres in California also have been withdrawn. The total of this class of lands withdrawn in California is 1,952,453 acres. Along the Green river in Utah 11,487 acres withdrawn for power purposes have been shown to have no value as such and are restored to the public domain. The Secretary of the Interior has designated under the enlarged homestead act approximately 7320 acres in Montana as being subject to the provisions of the act.

OPPORTUNITIES, RESPONSIBILITIES AND TRAINING NECESSARY FOR SUCCESS IN THE ENGINEERING FIELD.[1]

BY W. F. DURAND.[2]

I am to speak to you this evening on the factors which make for success in the field of practical steam and power plant engineering. I shall spend little time in any attempt at a definition of success. We all have our ideas and ideals of success, as diverse as the individual point of view; but through all this diversity there runs nevertheless a common core, and I shall assume that in essence we all mean the same by this term.

In its broadest sense success must depend on the entire man—physically, mentally, morally; and on all three as bound together and made effective by the purpose and will which lie at the very center of personality. I shall assume however that I am to limit our consideration of the hour chiefly to those factors which are mental in character rather than physical or moral not forgetting however their dependence on purpose and will as the central motive power.

I shall then take as a point of departure the general proposition that success inheres primarily in the following items of the make-up of individual personality:

(1) The general content of the memory as a storehouse of facts and principles.

(2) The general quality of mentality or of mental capacity.

(3) The manner in which the raw material classified under No. 1 is made use of by the mind, and is thus made to serve the purposes of the higher intelligence.

(4) The general purpose which lies back of all conscious action and the degree of continuity and force which is put into such purpose.

Of these subdivisions we may again say that the first represents raw material, the second the equipment by means of which the raw material is to be transformed into some useful product, the third the character of the transforming operations and the fourth the purpose and will back of the entire process.

In any arbitrary classification such as that which I have just suggested, it must be understood that the partitions which separate one item from another are often wavering and ill defined, and that at best any such attempt at classification is not to be viewed as more than an aid to an orderly examination of the subject. Actually the mind is not multiple but single, working it is true in many ways and through diverse channels, and thus naturally suggesting the use of schemes of classification when its processes are made the subject of examination.

We shall then find it of advantage to consider in some detail the content and character of these four arbitrary divisions.

The general content of the memory consists broadly of two groups of items: facts and principles.

The gathering of facts always precedes the discovery of principles. Facts in themselves are bald unrelated items and bits of nature's truth. Each fact gives, so to speak, a view of some microscopic part of nature as a whole, independent and unrelated to any and all other parts. Principles serve to relate facts, to bind them together according to some common characteristic, and thus to substitute for vast collections of separate bits of information, certain broad generalizations, each one of which represents in a comparatively simple manner a whole army of separate observations or facts.

Suppose by way of illustration that a man should undertake the examination of some complicated mechanism like the linotype machine in the following manner.

We suppose him first absolutely ignorant of the existence of any such mechanism. Then let him be blindfolded and brought to the machine and allowed to inspect some small portion, such for example as could be seen through an aperture one-eighth of an inch square, all other parts being kept covered. Then let him be again blindfolded and the location of the aperture changed to some other part of the mechanism, when he is again allowed a similar restricted observation. Each of these observations might be enrolled as a fact, a certain observed state of motion or rest. But how many such observations would be required or how long time would be involved in the comprehensive study of the movements of such a mechanism, or before any adequate idea of its character or purpose could be formed. On the other hand suppose the cover removed and a comprehensive view given at once. Immediately the causes of various groups of movements are seen to lie in suitable combinations of belts, cams, levers, linkage rods, sliders, etc. A thousand separate observations might have been made on the movement of some part of the mechanism, the reason for which now appears clearly in the form of a certain cam on a revolving shaft. Thus the cam, the belt, the linkage rod, serve to bind together and to explain hundreds and thousands of movements which viewed singly and individually might forever remain an unsolved puzzle.

In a similar manner the underlying principles in nature serve to bind together otherwise disconnected facts, and to thus relieve the memory of the need of any attempt at holding them stored and ready for immediate use. The point toward which I am approaching is of such great importance that I shall venture on another illustration.

Suppose that it were desired to establish the power which can be transmitted by leather belting under all usual mechanical conditions, and without the aid of any principles or theory regarding the matter whatever. Belting may vary from three-sixteenths of an inch to three-eights of an inch in thickness and not to make subdivisions of thickness too fine we may take one thirty-second of an inch as the difference, thus giving us seven different thicknesses. Then again we may have belts varying in width from say one-half inch to fifty inches, to carry the matter no further, and varying by say one-half inch intervals. This would give us one hundred different widths. Next we may apply tensions per square inch of belt section varying let us say from one hundred to two hundred and fifty pounds by five pound steps giving thirty different values for this item. And finally we may run such belts at speeds varying from let us say

[1]Paper read before California No. 3, N. A. S. E., Dec. 1, 1909.
[2]Professor of Mechanical Engineering, Stanford University.

two thousand to five thousand feet per minute by fifty feet per minute steps, giving sixty values of the operating speed. Then it would follow, in order to cover with this degree of fineness of subdivision the field mapped out, that we should have to make the number of experiments given by the product of these various numbers, $7 \times 100 \times 30 \times 60 = 1{,}260{,}000$. Even with this million and a quarter experiments there would be no ground, without calling on principle, for the application of these results to determine any case which might chance to fall intermediate between those forming the actual field of investigation. Suppose, however, the principles clearly established relating the power transmitted, to the various characteristics of the case, and as represented by the familiar formula for power transmitted by belting. Then we have at once, in such expression of principle, the embodiment of the entire series of 1,260,000 separate experiments, as well as of any and all other possible cases for intermediate values of the variables. With the formula only a few scattering experiments will be needed to give definite values to the constants and the principles thus represented in complete form will serve for ever after as the complete representation and embodiment of numberless facts of observation.

This distinction between facts and principles which is too simple and well known, perhaps, to have required consideration at such length, is however of the greatest importance for the engineer. He must of necessity have his memory stored with both and the value of his stock of raw material will be so much the higher as it includes a wider and better assortment of each. He should however remember that the effective capacity of the memory is limited and that no attempt should be made to load it up with vast numbers of unrelated and distinct facts of observation. The engineer must remember the important part which a proper grasp of underlying principles may be made to play, and so far as possible endeavor to substitute such principles for the disconnected body of facts. As I have before noted, the gathering of facts on the part of somebody must precede the discovery of principles, but once gathered and the principle developed, the latter should be given first place.

Thus to illustrate again, it might be a fact worth remembering that an eight by ten engine with steam at 100 pounds gauge pressure, running two hundred revolutions per minute, non-condensing and cutting off at one-third stroke, will develop about twenty-five i. h. p.; but is it not of far higher value to remember the common horsepower formulae, which will tell us not only the power for this particular case, but for any and all other similar cases as well.

Again the reduction of facts to principles is not always in the quantitative form. It often takes the form of what we term understanding, or knowing the reason why. And so I repeat that, while it is of importance to store the memory with facts, it is of still higher importance to endeavor to get back of the facts and apprehend the reason why. Thus all engineers know, or should know that low carbon-dioxide in flue gases means low boiler efficiency. This is good information in its way, but it is of higher value to know the reason why; and this implies an understanding of the principles of combustion. Or, again the engineer knows that the feed water heater is a possible source of economy; also the uptake economizer. These are bits of information, valuable in their way, but it is of higher value to grasp the principle underlying all such heat exchanges in their relation to power plant economy, and which may be expressed in the following form:

"Whenever a stream of outflowing heat energy (such as exhaust steam or flue gas) can be tapped or diverted and led in whole or in part into a stream or inflowing heat energy (such as feed water or inflowing air for combustion) the net wastage of heat to the outside will be decreased and an economy will result."

The clear and effective grasp of a principle such as this is better than any mere memorization of hundreds of disconnected facts relating to this special field of engineering work.

To sum up on this point I would say:

The mere memorization of bare facts as such is the lowest use to which we can put the memory.

The effective grasp of principles and reasons why and the holding of such in readiness for immediate use, is the higher function of the memory.

Recognition should constantly be given to this higher function, and to the extent to which it may be made of aid in the reduction and classification of facts and data, and their linkage together by means of underlying principles, of which they are merely the accidental expression.

So far as it can be done however without interfering with the higher function, the memory should also be stored with well selected concrete facts and data bearing on subjects of special interest to the individual.

We may next properly ask the questions:

(1) What sources are there for the acquirement of facts and data, and for aid in obtaining a suitable grasp of the principles of which they are the expression.

(2) What means are there for cultivating and improving the memory with reference to the ready use of this material for the study of engineering problems.

Of sources we may note the following:

(a) Books, technical and trade papers, and engineering literature in general.

(b) Conversation and personal contact with those whose experience and acquirements may fit them to serve as sources of reliable information or instruction on engineering subjects.

(c) Direct courses of instruction in night school, by correspondence, or otherwise.

Of these various sources I can only speak briefly.

First we shall agree that every engineer should have a good, even though small, working library of engineering books. The man who has purpose and ambition to rise will not hesitate to invest a moderate sum in such helps, an investment which in the long run is likely to net him returns of many hundred per cent in advancement along the pathway toward success. The same is true of technical journals. Every engineer should take and read at least one good technical periodical.

Again aside from books and periodicals which will require an investment in money, there is one general

source of information which may be developed, practically without limit, at the expense of a few postage stamps. I refer to the general trade catalogue and advertising matter which manufacturers are ever ready to send on request to any engineer sufficiently interested to ask. It is true that such material is put out in the interests of some particular item of engineering equipment and that in many cases the claims of special efficiency and superiority must be taken with some allowance. In a descriptive way however such material may be made of the greatest value to the young engineer, and he will perhaps find no more instructive way in which to acquire a knowledge of the main points of many items of engineering equipment than by reading them up in their advertising literatures and then striking a fair balance among rival claims. In some cases, notably certain boiler catalogues, large sums of money have been spent in compiling engineering data of great value and presenting it in a simple and convenient manner. Such books or catalogues represent in effect a combination of text book, hand book data, and trade catalogue and may frequently be made to serve purposes of the highest utility. It is a fact recognized by all progressive engineers that the trade catalogue, especially in a descriptive way, has acquired a place of definite value in the literature of the day, and represents a source of information and instruction which we can by no means afford to ignore.

I should in this connection most strongly recommend that every engineer should provide himself with trade catalogues from at least a few well selected makers of the leading items of power plant equipment, such for example as—engines, boilers, economizers, feed heaters, pumps, condensers, steam traps, regulators, reducing valves, gauges, pipe coverings, packings, etc. In particular should he have at hand such catalogues and descriptive matter relating to the particular makes of station equipment with which he may have to deal. A sectional diagram showing plainly the make of some pump, steam trap, feed heater or other item of equipment may often be of the greatest value in understanding its operation, or in detecting the sources of derangement and trouble.

Personal contact with engineers of experience may always be made a source of information for the man anxious to profit by such opportunities. All facts are gathered in the first instance as the result of personal experience, and in getting them first hand there is often some little touch of personality included which will help to deepen the impression and make its recall more ready in time of need. So when in the company of fellow engineers do not hesitate to talk shop or to swap experiences. To those of younger years I would say, do not be afraid to ask questions. In the great brotherhood everyone should be willing to help and every one willing to learn.

Perhaps this is as fit a point as any to speak of the note book as a place for the record of one's own experiences and observations. I have already spoken briefly of the limitations of the memory and of its higher functions. Do not be afraid to supplement it by means of the note book. Almost every day and frequently many times in the day the engineer will find himself in contact with something worthy of a place in his note book. It may be some bit of information or data acquired in conversation with others. It may be some idea of his own worth jotting down for development or mature consideration at a more convenient time. It may be some little sketch of something he has seen, or of something which has just been uncovered in the process of overhaul and repair. It may be the direct result of certain observations or tests which he is engaged in making. The accumulation of years of such gathering, with occasional siftings and compilations will represents a fund of information of ever increasing value. A hand book of engineering data is of course indispensable to the engineer; but in another sense every engineer should make his own hand book, home made and representing his own accumulation of facts, data and observation.

Turning now to courses of instruction of a more or less formal character, it is self evident that where such opportunities are open to the young engineer and where his personal and family duties will permit, they should be utilized to the highest possible degree. As a rule the courses of instruction offered by night schools or by correspondence schools represent the only opportunities open to engineers in practical life, and in such cases the work must be done out of regular working hours. It will mean then a definite addition to the working day and will call for a definite sacrifice of time otherwise given to leisure and rest. This is of course unavoidable, and means no more than the application of the inexorable law that no good thing can be acquired without paying for it by sacrifice in some form. I speak of the matter here only to say that this fact of added work and sacrifice of time for leisure and rest must be clearly understood at the start, and no one should undertake such courses who is not willing to make the sacrifice required. To discuss in any detail the question of such special courses of instruction would require more time than is at present disposal. I shall therefore point out briefly that the results in general will be two fold:

(1) The student will acquire a certain amount of information of which he was previously ignorant. That is, he will add to his general stock of information and facts, with special reference to the field of engineering work.

(2) He will acquire some better knowledge of how to think, how to reason, how to study, how problems are investigated, and some general familiarity with the fundamental sources of engineering information in books, journals, transactions of societies, etc.

In short he will have acquired some addition to his stock in trade, and some new mental habits and discipline. I do not hesitate to say that the latter is by far the more important of the two. If the fact is not at hand it can be looked up in a handbook of data or reacquired from a text book; but if the mind has never been trained in habits of close analytical study and is unacquainted with the methods and means by which engineering problems are investigated, such lack cannot be made up by turning to the pages of a book or to any source outside of the mind itself. This leads to an exhortation to those who may be pursuing courses of instruction of this character, and which is, that while the bald facts of information which are presented for study should not be neglected, first

place should be given rather to a persistent and definite effort looking toward a clear grasp of reasons why, and a clear understanding of the ways and means by which engineering problems are studied. The remainder of life will be available for the gathering of facts. There is no time so valuable as that in youth or early manhood for the acquiring of correct and efficient habits of thought. The acquiring of facts, as such, can also be done without the aid of the instructor almost as well as with. The development of correct habits of thought and of proper familiarity with the ways and means best suited to the study of engineering problems can be acquired in no way so effectively as by the aid of instruction and guidance from another person. Let me close this topic then by saying that the instructor or the source of instruction should be used by the student, not as a hand book of data or an encyclopedia of information, but rather as a means of acquiring correct habits of thought and a proper familiarity with and an understanding of the ways and means best suited to the effective study of engineering problems.

This is perhaps the most suitable point for saying a word with regard to the importance of mathematics for the engineer. It is closely accurate to characterize the work of the engineer as consisting chiefly in quantitative dealing with the substances and forces of nature. Whether or not he is aware of it, he is nevertheless constantly occupied in measuring things or in doing things of which the measure or quantitative relation to other things is the item of chief importance. Now mathematics is the science of quantitative relation, and whether the engineer knows it or not he must constantly be operating with the principles and methods of this science. I am well aware that mathematics unused becomes rusty—like any other good tool—and that few practical engineers have the opportunity to acquire working familiarity with the more especially advanced methods of mathematical research. These conditions are taken for granted and I do not wish to press the point too far. I wish only to say that in general the more mathematics the engineer has at his ready disposal the more readily he will be able to deal with various problems, and the more effective will be his grasp of the subjects presented for consideration and judgment. I recall a civil engineer with whom many years ago I worked as a school boy learning something of surveying, and who used to amuse his leisure hours by solving mathematical problems, calling them "mental food." Such varieties of food are perhaps less popular at the present time, but I am well persuaded that some moments given day by day to such study, especially on the part of the young engineer, would be of far more value than equal time given to the daily paper, the cheap novel or to other forms of harmless but also fruitless amusement.

If you ask why I single out mathematics for speical notice instead of discussing the value to the engineer of various other subjects of study, I would say that it is no part of my present purpose to discuss the relation of the curriculum of the technical school to the work of the practical engineer. He would of course find material of value in all such courses of study, had he the time and opportunity to pursue them. Mathematics, however, in some measure he must use daily, and I venture to say that there is no one subject of study considered as mental discipline which is of equal importance with reference to his general effectiveness and grasp of engineering problems.

We may now turn for a few moments to the consideration of methods for improving the memory. The value of a keen and retentive memory serving as a storehouse of facts and principles, ready on the instant to supply any reasonable demand, cannot be exaggerated. How can such a memory be acquired? Time fails for any comprehensive discussion of these matters and I can only refer very briefly to certain underlying principles.

(a) The quality of memory differs much between individuals. This we must accept as a fact. The main question is how to effect improvement.

(b) The ability to call up at will the contents of the memory depends primarily on two conditions:

(1) The distinctness of the original impression.

(2) The frequency with which the original impression is revived by being called before the notice of the active upper consciousness.

It is a well established fact of modern psychology that whatever has definitely impressed the upper consciousness has gained a place in memory. This impression, however, may vary from a slight and almost vanishing touch to a record so deeply graven that nothing can serve to effectively erase. In general the original impression is the deeper and more lasting according to the degree of fulfillment of some one or more of the following conditions:

(a) Deep emotion connected with the impression.

(b) Deep and earnest concentration of attention on the subject matter to which the impression relates.

(c) A definite act of the will directed toward the deepening of the impression when first made.

Under ordinary circumstances the latter two only are available in connection with the events of every day life. To illustrate, suppose the young engineer overhears in conversation a statement of the fact that the heat value of good California fuel oil is about 18,750 heat units per pound and desires to remember such fact. He may definitely deepen the impression on the memory by some such procedure as the following:

He slowly, distinctly, and preferably with audible voice repeats to himself the number 18,750 as the heating value of oil. At the same time he visualizes the number, that is, pictures to himself how it looks. All this is done with a keen and definite concentration of attention on the number and its meaning and coupled with a focussing of will power upon the making of a deep and lasting impression on the memory.

So much for the original impression. Now with regard to recollection (the recall at will of these impressions) we find two chief aids:

(a) Repetition.

(b) Association.

Memory works most easily along accustomed channels and no matter how deep the original impression it will after a time become obscured by the more

recent content of the memory unless the earlier impression is renewed from time to time. After many renewals the impression may have gained so definite a place as to come readily at call, even after long periods of disuse. To pursue the simple example above, if the heating value of fuel oil is to be remembered and held ready for instant service, it must be brought out of the dim back ground of consciousness from time to time and the original impression renewed. Whenever the matter of the heating value of fuel oil may present itself the occasion will serve for such renewal of the original impression. If the matter does not come up in the ordinary course of events, then it should be brought up by the mind. Thus matters of any character whatever which we are desirous of remembering promptly and which we may have impressed on the memory with special concentration, should be reviewed from time to time and the impression thus renewed until the item has acquired status in that part of the memory which is under immediate and full control of the will.

Aid may also be realized by judicious use of the association of ideas. We all know how one thing will suggest another, and how a whole train of thought may spring from some one minor item as starting point. Many people make valuable use of this principle in the cultivation of the memory. I shall not attempt any discussion of the methods in detail, and only mention it in passing, leaving to each one the application to such extent as may seem effective.

We may now turn to the second principal subdivision of our subject, Quality of Mind.

We must admit, of course, that there are differences in mental endowment. Within limits the individual is not responsible for these differences. Responsibility cannot be evaded, however, for the manner of use of such endowment as we may have. Furthermore I wish to point out most emphatically that success in life in no matter what calling depends far more on the manner and extent of use than on the mere degree of initial mental equipment. Paraphrasing the scriptural parable of the talents, we may say that one talent put to use is far more effective than ten talents laid away in a napkin. I shall not attempt any survey of mental equipment in general or even of those items which might be supposed to relate especially to the work of the engineer. Time fails for such examination and there is the less need, because the basic characteristics of such equipment are beyond the control of the individual, and his larger responsibility begins with the use of such endowment as he may have, rather than with the initial character of the endowment itself. If there is any one truth in this connection, the application of which should be allowed to sink home, it is that genius is the result of mental endowment, made fruitful by untiring industry, continuing purpose and indomitable will. In the familiar phrase—"Genius is an infinite capacity for taking pains." The development of untiring industry, continuing purpose and indomitable will; the development of some capacity for taking pains, all these are within the grasp of the individual. Therefore genius in some measure lies within the grasp of him who will reach forth and take.

Again with use the quality of mental endowment will improve, new powers will develop and new achievements will come within reach.

To sum up under this head:

The individual is responsible for his basic mental equipment only to the extent to which it permits of enlargement and improvement by use. He is responsible in full for the measure and manner of use, because these depend on will, and will is the core of individuality.

Whatever may be the mental endowment therefore, let no man be discouraged. Use will bring development and growth and the history of civilization is filled with the records of men who, with only moderate mental endowment held steadfast with fixed determination, have far distanced in useful achievement others who, with higher natural endowments and advantages, have lacked the element of purpose and power of soul.

Turning from this brief reference to mental endowment as such we approach our third subdivision, the method and manner of its use.

The work of the engineer is readily divided into two principal fields:

(1) The performance of routine duties, without new elements, and in which are involved only the performance of accustomed operations, either mental or physical.

(2) The study of new problems.

While the importance of the first of these must not be forgotten, we find our chief present interest in the second division—the study of new problems.

How then shall we most advantageously approach the study of such problems? Here again we find two chief classes into which such problems are naturally divided.

(a) Those in which the desired end or object is known and we are to discover the way of achievement.

(b) Those in which some specified combination of conditions is proposed or known and we are to determine the results.

In the first we have fundamentally the problem of the inventor who is ever seeking new combinations through which some desired end may be realized, or again the problem of search for the causes of some specified or known condition or trouble. In the second we have the familiar problem of determining from known or proposed conditions, the unknown result. Both classes of problems involve the same fundamental items, the chief difference being in the point of view. In one it is relatively forward, in the other backward. In both it involves two primary mental operations—(a) the determination of the influences of various individual factors which may enter into the problem and (b) the mental combination of these various individual items or influences into one final result.

The highest degree of effectiveness will come then when all the factors which may possibly have any bearing on the problem are marshalled in order, passed in review, given each its due individual weight, and then combined with careful judgment into a final result. This discussion of mental processes is perhaps likely to seem academic and may be tedious. Some understanding of these matters is, however, of importance as an aid toward clearer and more effective

thought and study. Daily the engineer traverses operations of this character which through familiarity are carried forward almost instinctively and without conscious note of their exact character. Let me illustrate. In passing a given boiler note is taken of the fact that the water is low in the gauge glass and a moment's examination serves to show that no feed is coming through the check valve. This means a condition of trouble which must be instantly investigated, its causes determined and removed. Instinctively the engineer passes in review all possible causes of such a condition. The check valve may have been accidentally closed, it may have become jammed on its seat, the opening may have become clogged with waste or some other foreign substance, there may be a leak in the feed pipe, the feed pump may have stopped and if so, due to a whole series of causes which will be rapidly brought to mind if such is found to be the case. Then a rapid and systematic search will be started for the determination of which cause or what combination of causes is responsible for the given condition. One by one they will be eliminated until finally the explanation of the condition will be found and the basis for a judgment as to the best method of correction will be provided. Now it is clear that in any such problem efficiency of treatment requires three things in particular:

(1) The determination of all the factors.

(2) The assignment to each factor of its proper influence and importance.

(3) The development of a composite judgment based on the action and interaction of these various individual factors.

Again suppose we analyze the process by which the inventor proceeds in the search for some improvement or new development in the line of engineering equipment.

Suppose him to be in search, let us say, of a steam meter. He might perhaps analyze out the problem somewhat as follows:

Purpose in view, measurement of flow of steam in pounds per minute or per hour.

Weight of steam flowing along any pipe or through any orifice depends on three factors—area of stream of flow, velocity, density.

Steam as furnished from boiler may naturally vary in pressure and hence in density, also possibly in quality or degree of moisture.

The chief variable factors to be provided for are therefore variation in demand on the part of the consumer and variation in pressure and density on the part of the boiler.

These changes are then available to actuate some indicating or recording mechanism.

If for example the area is kept constant, means must be sought for causing the varying density and varying velocity to properly affect the registration of the apparatus.

If otherwise the velocity is kept constant then means must be sought to connect varying area and varying density with the registration of the apparatus.

And if finally density could be kept constant, then it would be sufficient to keep either velocity or area constant and to effect the registration by means of the one variable element.

The next step in the survey of the field would be the determination of all possible means by which change in velocity, or change in area or change in density could be made to affect the registration of an instrument. With such a survey completed the possibilities are in hand and it then becomes a matter of choice as to what combination of possible means and methods will be most effective for the purposes in view.

Such processes are typical of all search for the unknown, though we are not always careful to go about them in a thorough, systematic and exhaustive manner. Such processes always involve the analysis of a desired result into its various component factors, and the utmost care is necessary in order to be sure that the list is complete—that all the factors are included. Then comes a search for the various means of realizing mechanical embodiment for such factors, having in view the purpose desired. Here again the search must be exhaustive. We may safely assume that there are many ways of realizing any individual purpose or element of our problem, and it is very unlikely that the method which may first present itself will be the best of all. Further search should be made and a persistent effort must be directed toward the discovery of all practicable ways of realizing the particular purpose, and then a choice may be made.

All this is perhaps commonplace, but I am desirous of impressing, especially upon the younger members of the association, the high importance of bringing to every problem with which they may have to deal the highest qualities of mind backed by determined purpose, and of knowing no rest short of its thorough and systematic study along lines as indicated above.

Another powerful help in connection with the growth of the engineer in effective capacity may be found in the development of what may be called organizing centers, each in connection with some special class of topic in which keen interest is felt. The conditions for such development are first and foremost the existence of a definite and keen interest on the special topic in question, and then a direct and strong effort on the part of the will to refer everything in the way of facts, information and data relating to this topic, to this particular center of the mind for organization and safekeeping. This principle is so important that I wish to illustrate by a simple example.

Suppose we have two young engineers, A and B, with equal general educational advantages and training. Suppose that neither has yet been brought into very close contact with the special conditions which influence power plant economy. Suppose that A feels no special interest in such matters and has no special ambition to become posted with regard to the principles on which economy must depend; while B on the contrary feels the keenest interest in such matters, and has a determined purpose to thoroughly master the underlying principles. Such men from time to time will come into contact with many items of information relating to this general topic. To B they will have definite meaning, and will be eagerly absorbed by the memory. To A they will be next to meaningless and will make on the memory only the most fleeting impression. Thus the power plant may be visited

by some authority on the subject, and in conversation certain definite facts of importance and value may be mentioned. In the case of A they will enter the ears and cause the sensation of hearing, simply as a phrase or two of conversation. In the case of B they will be recognized instantly as facts or information corresponding to a well developed interest, and will be carefully stored away and grouped around such grasp of principle as may have been acquired regarding these matters.

In all this there is little of conscious effort. There is the existence of interest, attention, and a receptive, responsive condition regarding all such matters. Under such circumstances there is a natural almost unconscious absorption of such facts and items of information, and an equally unconscious reference of them to the organizing center which has begun to develop with reference to this particular topic. It will be found that after a time a very considerable body of information relating to this topic will have been acquired by B, with little of direct or conscious effort, and that such information will have gradually become organized, or crystallized, so to speak, about a center which may be called "interest in power plant economy."

In a similar manner by developing suitable interests, other lines of data and information may be acquired and organized in like manner. Thus such organizing centers may be developed with reference to many special topics of importance to the engineer, such as matters of cost and the general subject of the finance of power plants; matters relating to the organization and administration of power plants and other industrial undertakings; matters relating to the shop construction of the items of power plant equipment, etc., all of which will help to make him broader and more effective in the discharge of the daily duties of his calling.

Without such development of interest and of such centers of organization for groups of information and data, A may pass through the same environment, come into momentary contact with the same facts and opportunities, but with absolutely nothing of solid acquirement to show as a result.

I wish to speak now briefly of the source of errors made by engineers, and of the most effective means of overcoming, presumably the largest class. This is distinctly a practical question. We all know that we are subject to the making of errors. What are their sources and how may they be avoided.

We may conveniently note three classes of errors:

(1) Errors of ignorance.

(2) Errors of judgment.

(3) Errors due to lack of attention.

Errors of ignorance we all make. We are uncertain regarding some of the elements of our problem and we guess, or make some attempt at an estimate or determination, and an error is introduced. Such errors are not made unconsciously. We know of the uncertainty in our factors and realize that the final result must of necessity involve a similar margin of uncertainty. Much more dangerous are the errors which we make when we think we are right but are misled or mistaken. Here we may give full weight to our results, when in point of fact they involve the consequences of the error unconsciously made. There is no royal road for avoiding the errors due to ignorance. We can only strive to be sure of our facts if possible, and if not, to make the best possible estimate of the measure of uncertainty which may be introduced into the result by such uncertainty in the primary factors. If for example we obtain a final result which we estimate to involve a possible error of ten per cent in either direction, it is better perhaps than having no result at all, and better than having a result in which the error may be of unknown magnitude. Against unconscious errors of ignorance we can only exercise the keenest scrutiny of factors and datta, and endeavor to trace each item back to a thoroughly reliable source.

Against errors of judgment we have no general remedy. These again we all are liable to make. Our view of the various factors may be faulty or incomplete, our estimate of their relative influence or importance inaccurate, and so with the best of purposes we may arrive at faulty conclusions. Here again, painstaking care in the determination of the various factors and in the assignment of individual values, with careful weighing of each, separately and in combination, are the chief means available for leading us to correct conclusions from given initial data.

It is rather with reference to the third class of errors that I wish to speak, because such errors are made many times more frequently than those of the other two classes.

In this class we may include all errors of a numerical character, and in general all errors made in violation of our own knowledge when the mind is properly focused on the matter.

The mind has a valuable but at times a dangerous habit of going on working in an automotic or semi-automatic manner even when the attention is not keenly focused on the subject matter in hand. This is particularly the case when it is concerned with very familiar operations such as adding a column of figures, or doing a problem in multiplication or division. We all know how the attention can wander during such an operation. Entirely outside thoughts may float through the mind distracting the attention, or again keen interest in the subject in hand may tempt the mind to rush on ahead and consider other matters while almost like a machine the mental faculties are going through familiar arithmetical operations. All this would be well, if the automatic part of the operation could be depended on. But unfortunately it cannot. It is just when the mind is in such a state of divided attention that we say $6 \times 9 = 45$ or $9 + 8 = 18$ or $8 \times 9 = 72$ and 6 are 60 or other like errors. These are statements the error of which we instantly detect when the attention is focused on the matter, but which slip by unchallenged when the attention is directed elsewhere. Again in copying numbers from one place to another we may transpose or invert, as for example writing 756 instead of 657 or 9236 instead of 9326. Again we may take the price of something per pound instead of per foot, or we may use inches for feet or feet for inches. In short there is no end to the foolish and erroneous things which we may do

when the attention is thus relaxed or divided. Practically everything which we do correctly when the attention is properly focused, we may do incorrectly when such oversight is wanting. In the familiar phrase we know better but didn't think. The proper answer of our employers is that as long as we know better we should think, for that is what we're paid for.

There is no need of enlarging further regarding the character or frequency of such errors. We have all doubtless had keen personal experience of them. Now there is one and only one remedy. That is, never for one instant to relax the attention when engaged in operations of this character, and the more familiar the operations are, the more the tendency of the attention to wander and the greater the danger of running astray. It is not too much to say that it lies within the capacity of any one who chooses, to eliminate practically all errors due to such sources. It simply means undivided attention definitely focused directly on the matter in hand, and a resolute steadfast exclusion from the mind of all external beguiling topics. I speak of this matter with emphasis because it is of importance to us all in the every day duties of our calling. In some cases the frequency of such errors has seriously reduced the value of otherwise good engineers. I am convinced that any one with determination can break himself of the liability to errors of this character. It is simply a matter of a concentrated focus of attention. Purpose and will lie at the foundation, and to these we must now turn in closing.

This is a final point which needs no extended development. The conditions are demonstrated on every hand and by experience as old as the world's history. The progress of civilization has been marked times beyond number by failure or by half success on the part of those with good natural endowment and advantages, but who have lacked this one final element essential for success; while on the other hand the world's history has been made and the world's civilization has been achieved in very large measure by men and women of only moderate initial endowment and often in spite of serious handicap of one form or another, but who have been fired with courage, purpose and determination.

The world's work today is being done and the new developments of the age are being opened up, not by natural born geniuses (if there are such) not primarily by those who have had the best advantages of birth and training, but rather by those who have become inspired with the largest measure of soul and purpose. In a very real sense we are coming to see that man is what he wills to be. Many elements must of necessity enter into the final make up of what we call success. I have endeavored to indicate some of them. Personality, morality, some element of what seems to be chance, these and others will also enter into the final complex result; but the greatest of all, certainly of those for which we as individuals have any measure of responsibility, is the element of purpose. And so as the closing thought, and one which I trust may be carried away and into the duties of everyday life, I would simply say that success awaits the grasp of him who wills to reach forth and take.

RECENT DEVELOPMENT OF THE PRODUCER GAS POWER PLANT IN THE UNITED STATES.[1]

BY ROBERT HEYWOOD FERNALD.

It was not until late in the nineteenth century that the gas engine came into common use, and although many types have been devised within the last twenty or thirty years it is only within eight or nine years that large gas engines have been constructed. This development started eleven or twelve years ago in Germany, Belgium and England, but marked progress has been limited to the last eight years.

For a long time the natural fuel of these internal-combustion engines was city gas, but this was too expensive except for engines of small capacity. It was seldom found economical to operate units of more than 75 horsepower with this fuel. Cheap gas was essential for the development of the gas engine, but the early attempts to produce cheap gas were somewhat discouraging, and for a time it seemed very unlikely that the gas engine would encroach to any extent on the field occupied by the steam engine. The theoretical possibilities of the internal-combustion engine operating with cheap fuel promised so much, however, that the practical difficulties were rapidly overcome, with the result that the internal-combustion engine has become a serious rival of the steam engine in many of its applications.

The development of the large gas engine within the last few years has been exceedingly rapid. It was only nine years ago that a 600- h. p. engine exhibited at the Paris exposition was regarded as a wonder, but today four-cycle, twin-tandem, double-acting engines of 2,000 to 3,500 h. p. can be found in nearly all up-to-date steel plants, and there are installations in this country containing several units rated at 5400 h. p. each.

The rapid advance of the large gas engine was made possible by improvements in the production of cheap gas directly from fuel by means of the gas producer. An early form of producer introduced in Europe, and now in general use both abroad and in the United States, is known as the suction producer, a name suggested by the fact that the engine develops its charge of gas in the producer by means of its own suction stroke. Although many producers of this type are now used, most of them are small, seldom exceeding 200 horsepower. A serious limitation to the utility of the suction producer has been the fact that, owing to the manner of generating the gas, no tarry fuels could be used, a restriction that prevented the use of bituminous coals, lignites, peats, and other like fuels. The fuels in most common use for producers of this type are charcoal, coke, and anthracite coal, although attempts are being made so to construct suction plants that they can be operated with bituminous or tarry coals.

To meet the demand for the concentration of power in large units, instead of operating a large number of separate installations of small power capacity, the pressure producer was devised. This producer develops its gas under a slight pressure due to the introduction of an air and steam blast, and the gas is stored

[1]Summarized from Bulletin 416, U. S. Geological Survey.

in a holder until it is required by the engine. As the gas may thus be stored before passing to the engine, and as its generation does not depend on the suction stroke of the engine, tar and other impurities may be removed from it by suitable devices, and the use of bituminous coal, lignite, and peat is thus permitted.

The pressure producer was closely followed in the course of development by the down-shaft producer, which fixes the tar as a permanent gas and therefore completely uses the volatile hydrocarbons in bituminous coal, lignite and peat.

A few scattered producer-gas plants were installed for power purposes in the United States before 1900, but the application of this type of power in any general sense has been developed since that date. During the first few years of this period of development antharcite coal, coke and charcoal were used almost exclusively, although occasionally pressure and down-draft plants ventured to use a well-tried bituminous coal known to be especially free from sulphur and caking difficulties and low in both ash and tar making compounds. The rapid development of the anthracite plant was to be expected, but it remained for the United States Geological Survey in its testing plants at St. Louis and Norfolk to demonstrate the possibility of using in such plants practically all grades of fuel of any commercial value, without reference to the amount of sulphur or tarry matter which they contain.

In considering the relation between the economic results of plants of the two types under discussion, namely, steam and producer-gas, the fact should be remembered that today, in the ordinary manufacturing plant operated by steam power, less than 5 per cent of the total energy in the fuel consumed is available for useful work at the machine.

In that connection it is of interest and value to glance at the possibilities of the best designed and most skilfully operated commercial plant now in use. The data concerning the steam plant selected for this determination are derived from a table prepared by Mr. Stott, superintendent of motive power, Interborough Rapid Transit Company, New York City, which, as Mr. Stott says shows "the losses found in a year's operation of what is probably one of the most efficient plants in existence today, and, therefore, typical of the present state of the art."

Average losses in steam plant of the Interborough Company in converting 1 pound of coal, containing 12,500 British thermal units, into electricity.

	British thermal units.	Per cent.
Loss by friction	138	1.1
Loss in exhaust	7,513	60.1
Loss in pipes and auxiliaries	275	2.2
Loss in boiler	1,000	8.0
Loss in stack	1,987	15.9
Loss in ashes	300	2.4
Total losses	11,213	89.7
Energy utilized	1,287	10.3
	12,500	100.0

Mr. Stott further presents a table showing the thermal efficiency of producer-gas plants, concerning which he says:

The following heat balance is believed to represent the best results obtained in Europe and the United States up to date in the formation and utilization of producer gas.

Average losses in a producer-gas plant in the conversion of 1 pound of coal, containing 12,500 British thermal units, into electricity.

	British thermal units.	Per cent.
Loss in gas producer and auxiliaries	2,500	20.0
Loss in cooling water in jackets	2,375	19.0
Loss in exhaust gases	3,750	30.0
Loss in engine friction	813	6.5
Loss in electric generator	62	.5
Total losses	9,500	76.0
Converted into electric energy	3,000	24.0
	12,500	100.00

The thermal efficiency of such plants, as given by different writers, runs as high as 33, 36 and 38.5 per cent, and for some plants figures as extravagant as "above 40" are boldly published. Although the present aim has been to give figures for a producer-gas plant that may compare favorably with those of the steam plant of the Interborough Company, an effort has been made to keep well within obtainable efficiencies. Attention is also directed to the fact that the producer-gas plant considered should be large enough to compare favorably with the steam plant. This precludes comparisons with suction plants, which are relatively small but give higher proportional efficiencies than the larger pressure and down-draft plants, for these require more or less auxiliary apparatus.

Mr. Stott seems ready to accept a thermal efficiency of 24 per cent for the best producer-gas plants for comparison with 10.3 per cent efficiency for his steam plant, but a careful study of the problem has led to a more conservative estimate for the producer-gas plant, namely, 21.5 per cent.

The tables just given show the comparative efficiencies reached in plants of the best type, both steam and producer-gas, but these are seldom realized in common practice. The results obtained in the government plant at St. Louis are probably more nearly representative of the ordinary type of apparatus. These results are as follows:

Relative economics of steam and gas power plants at St. Louis in the conversion of 1 pound of coal containing 12,500 British thermal units into electricity.

	Steam power.		Gas power.	
	British thermal units.	Per cent.	British thermal units.	Per cent.
Losses in exhaust, friction, etc.	11,892	95.14	10,812	86.5
Converted into electric energy	608	4.86	1,688	13.5
	12,500	100.00	12,500	100.0

Especial attention is called to the fact that several low-grade coals and lignites that have proved of little value or even worthless under the steam boiler have given excellent results in the gas producer.

The ratios of the total fuel per brake-horsepower hour required by the steam plant and producer-gas plant, under full load, not counting stand-by losses, are presented below as derived from 75 coals, 6 lignites, and 1 peat (Florida).

Ratios of Fuel Used in Steam and Gas Plants.

Average ratio, coal as fired per brake horsepower hour under boiler to coal as fired per brake-horsepower hour in producer 2.7

Maximum ratio, coal as fired per brake-horsepower hour under boiler to coal as fired per brake-horsepower hour in producer 3.7

Minimum ratio, coal as fired per brake-horsepower hour under boiler to coal as fired per brake-horsepower hour in producer 1.8

Average ratio, lignite and subbituminous coal as fired per brake-horsepower hour under boiler to lignite as fired per brake-horsepower hour in producer 2.7

Maximum ratio, lignite and subbituminous coal as fired per brake-horsepower hour under boiler to lignite as fired per brake-horsepower hour in producer 2.9

Minimum ratio, lignite and subbituminous coal as fired per brake-horsepower hour under boiler to lignite as fired per brake-horsepower hour in producer 2.2

Average ratio, peat as fired per brake-horsepower hour under boiler to peat as fired per brake-horsepower hour in producer 2.3

The figures for the producer-gas tests include not only the coal consumed in the gas producer, but also the coal used in the auxiliary boiler for generating the steam necessary for the pressure blast—that is, the figures given include the total coal required by the gas-producer plant.

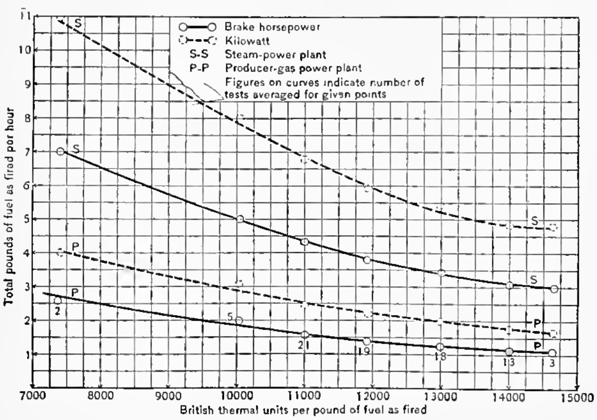


Fig. 1.—Comparative Service of Coals and Lignites in Producer and Steam Boiler Plants.

The curves in Fig. 1 show graphically the great economy secured from the 75 bituminous coals and 6 lignites when used in the gas producer instead of under the steam boiler. The results of the tests are officially reported on the basis of switchboard horsepower, but in order that they may be of more practical value they are given here on the basis of brake horsepower and kilowatts—the efficiency of electric generator and belt in each plant being assumed as 85 per cent.

In the above comparisons between the steam and producer-gas plants no consideration has been made of stand-by losses. The result for each plant has been derived from experiments made during continuous operation for a given period. Data on stand-by losses for plants operated during a portion of each 24-hour day are not at present obtainable at the fuel-testing plant. Very few results of experiments relating to this point have been published, and opinions regarding the amount of fuel required for holding fires over night or during idle periods in both boiler and producer plants seem to differ widely.

In considering the possible increase in efficiency of the steam tests with a compound engine, as compared with the simple engine used, the fact should not be overlooked that a corresponding increase in the efficiency of the producer-gas tests may be brought about under corresponding favorable conditions. Not only is the producer passing through a transitional period, but the gas engine must still be regarded in the same light. In the larger sizes the vertical single-acting engine is being replaced by the horizontal double-acting engine. Other changes and improvements are constantly being made which tend to increase the efficiency of the gas engine, as compounding and tripling the expansions have already increased the efficiency of the steam engine.

As has already been stated, the gas engine used in the tests here reported is of a type that is rapidly becoming obsolete for this size, namely, the vertical, three-cylinder, single-acting.

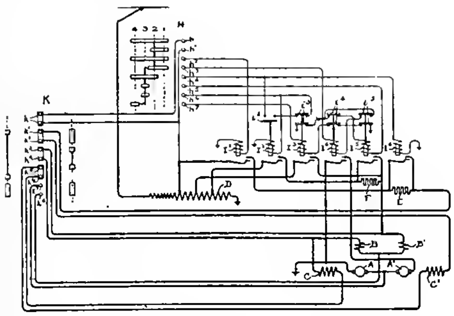
A brief consideration of these points will lead at once to the conclusions that a comparison of the producer-gas plant and steam plant used in these tests is very favorable to the former, and that any increase in efficiency in the steam tests that might result from using a compound engine can be offset by the introduction of a gas engine of more modern type and a producer plant designed to handle the special kinds of fuel used.

It should be noted that many fuels which give poor results under steam boilers have been used with great ease and efficiency in the gas producer, which thus makes it possible to utilize low-grade coals and lignites that have heretofore been regarded as practically useless. Several of the poorest grades of bituminous coals have shown remarkable efficiency in the gas producer, and lignites and peat have been used in it with great facility, thus opening the way to the introduction of cheap power into large districts that have thus far been commercially unimportant owing to lack of industrial opportunities. Experiments with "bone," a refuse product in bituminous-coal mining, have given excellent results, showing an efficiency in the producer equal to that reached by good steam coal under boilers. Recent investigations with other low-grade fuels, such as mine roof slabs, culm, and washery refuse, have also demonstrated the possibility of using such material to advantage in the producer under proper commercial conditions.

It has not been the aim of the testing plant to determine the lowest possible amounts of coal that could produce a given amount of power or to determine the highest possible efficiency of the particular producer plant installed. By an act of Congress, the work of the plant was restricted to the determination of the possibilities of utilizing bituminous coals, lignites, and other fuels for the production of power. In spite of the fact that no series of runs has been made on any one coal for determining the best possible results obtainable, it is nevertheless gratifying to report that official records show that as small an amount of dry coal as 0.95 pound per hour has been burned in the producer per electrical horsepower developed at the switchboard; or 0.80 pound of dry coal per hour has been burned in the producer per brake horsepower per hour, on the basis of an efficiency of 85 per cent for generator and belt.

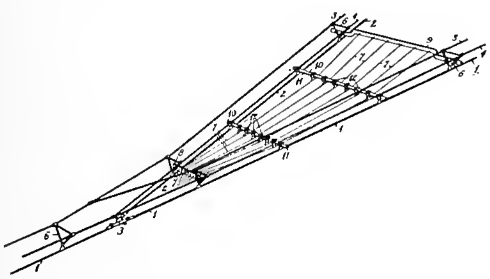
PATENTS

946,751. Alternating-Current-Motor Control. Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company. In combination with a pair of alternating-current motors of the commutator type having their armatures normally connected in series, a control system arranged to short-circuit said armatures for low-speed operation and to open the



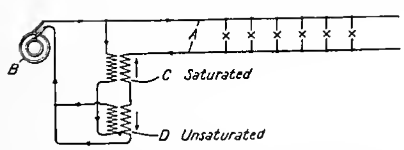
short-circuit and impress a voltage on said armatures for high-speed operation, a cut-out switch arranged to cut either of said motors out of circuit, and means controlled by the cut-out switch for rendering the control system inoperative to establish the high-speed connections when one motor is cut out.

946,590. Electric-Trolley-Line Construction. Theodore Varney, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. In an electric line construction, the



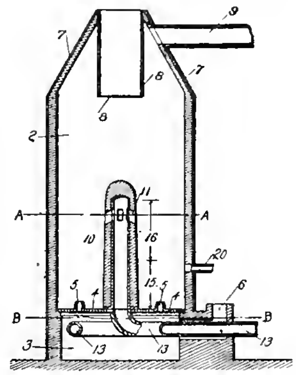
combination with trolley conductors forming a V-shaped junction, and supporting means therefor, of a plurality of diverging guard wires located between the trolley conductors, supporting cross-bars clamped to the ends of the guard wires and to certain trolley conductor supports, and intermediate cross pieces clamped to the guard wires and provided with trolley hangers.

946,829. Compounding Alternating-Current Circuits. William Stanley, Great Barrington, Mass., assignor to General Electric Company. In combination with a load circuit and a



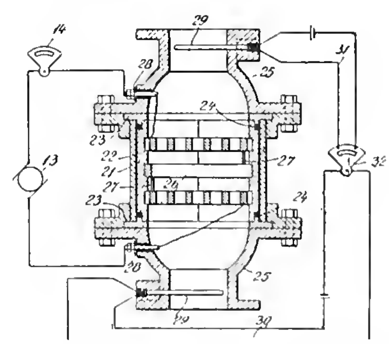
source of alternating current therefor, means for compounding the voltage supplied to the circuit under varying load comprising two transformers having their primaries connected in series with each other and in shunt to the source and their secondaries connected in series with each other and with the load, the cores of the two transformers being so proportioned that one is saturated and the other unsaturated.

946,820. Gas-Producer. Thomas Clouston, Vancouver, British Columbia, Canada. In a gas producer, the combination with a generating chamber having a partition grate across the bottom and a charging inlet projected within the top, of means for delivering air from the space beneath the par-



tition, grate through twyers upwardly projecting from the partition, means for collecting gas generated from about the mid-height of the generating chamber and for delivering the same through a passage exposed to the heat of the incandescent fuel in the lower part of the same chamber, and means for delivering the hot gas so collected through a pipe exposed to the incoming air in the space beneath the partition grate.

946,886. Method of and Apparatus for Determining Rate of Flow of Steam and Other Gases and Vapors. Carl C. Thomas, Madison, Wis. The method of determining the rate of flow of wet steam and like vapors, which comprises passing a moving current of such vapor in heating proximity to electrical resistance means, passing through such resistance



means electric current sufficient to generate enough heat to superheat the vapor and so convert it into gas, and also passing through such resistance means a further known amount of current and determining the rise of temperature produced in the gas, during a unit of time, by the passing of such additional amount of current.

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas." Weekly.

FOUNDED 1887 AS THE
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CONTENTS

Pinchot-Ballinger

The attitude of the "Journal" towards Mr. Gifford Pinchot, has been always one of friendly fairness. We have admired the man, though forced to deplore, at times, an uncompromising zealotry that seemed to possess him. That gentleman was so impressed with our fairness of statement in our discussion of the hydroelectric problem that he quoted in "Conservation" one of our editorials in full, declaring it to be "As fair and logical a presentment of the case as we recall having seen in a long while."

With this introduction the casual reader will not misunderstand what follows.

It is deplorable that a man who could have been of such vast service to his country as Mr. Pinchot might have been, should have disqualified himself from further usefulness to the nation as a public officer, through his own deliberate act. An insubordinate subordinate is intolerable in any employment. Mr. Pinchot understands this as well as anyone.

Personally we believe Mr. Pinchot invited his own dismissal—nay, more than that, he demanded it. There was nothing left for the President to do. For a like offense Mr. Roosevelt would have dismissed Mr. Pinchot quicker than did Mr. Taft, but with more pyrotechnics. Harsh criticism of Mr. Taft for his action is unjustifiable. If the offending Pinchot could not possibly be replaced, such criticism might be natural, even though unfair.

Of course it is going too far to say of Mr. Pinchot that he is the only man in America honest enough or wise enough to supervise the great work of conservation. There are others who will do as well and who, lacking certain personal peculiarities, may do better than he. The same may also be said with equal truth of Mr. Ballinger.

Mr. Ballinger has not yet placed himself in a position justifying his dismissal, unless we prejudge his case. But this much seems quite certain. He ought to resign. He ought to relieve the President and the entire country by withdrawing unequivocally, whether he be under fire or nor under fire. As a friend, he is not an administration asset—he is a liability.

Believing that Mr. Pinchot, rather than resign, deliberately invited, if not planned, his own dismissal; and believing too that he is a fair minded gentleman, it is somewhat inexplicable that he should permit the President to be harshly criticised for the doing of a thing he had rendered compulsory. Some men in Mr. Pinchot's place, no matter what their personal feelings might be, would issue a statement that would relieve the President of unjust criticism, of unwise friends. And we must confess to liking such a man.

If Mr. Pinchot, for some cause or other, had decided to get out of office, and if he then carefully planned not to resign but to commit some overt act that would inevitably bring about his dismissal, so as to injure the administration, and bring upon it unjust

criticism, and if this was his deliberate purpose, as it seems to have been, then we must amend our views of Mr. Pinchot's personality.

Producer Gas Power

Until ten years ago the theoretical efficiency of producer-gas power was the will-of-the-wisp that lured many a dollar from the pocket of the power plant owner. Made chary by initial impressions, which are proverbably lasting, he is now slow to be convinced that recent improvements in both the producer and the engine have given a power plant that is at once efficient and reliable. The case is in many respects similar to that of the electric vehicle, whose early defects have prejudiced people against its present perfections.

Producer-gas is the result of the incomplete combustion of coal, its active constituents being carbon monoxide and hydrogen, diluted with a large amount of inert nitrogen. Mixed with air and exploded in the cylinder of a gas engine it drives the piston, thus effectively utilizing from two to three times as much of the energy available in the coal as does the steam engine.

Its great success has been with anthracite coal, although experiments made by the Fuel Testing Department of the United States Geological Survey show that bituminous coal, bone coal, lignite and peat can be successfully utilized. More than half of the total producer-gas horsepower in this country is developed from bituminous coal and lignite. For this purpose the suction producer has not proved uniformly satisfactory, the pressure type being seemingly better adapted for soft coals. The producer is yet in a state of transition; the apparatus has not become standardized as has steam equipment; few engineers understand how to handle a plant to the best advantage; its initial cost is high. These disadvantages, however, are but transitory and are already more than compensated by the low cost of its power. There can be little doubt but that in time producer-gas plants will be centralized in the coal mines as have been hydroelectric plants at the water power sites, and the energy distributed either by means of high pressure gas mains or long distance electrical transmission.

Last month the members of the California No. 3, National Association of Stationary Engineers, were favored with one of those whole-souled talks of advice that have endeared Professor Durand to all of his students. Through the courtesy of the Association we are enabled to print this address elsewhere, and would commend its perusal to all of our readers. His talk is concerned primarily with the mental equipment that brings success. Being intended for the steam engineer it employs mechanical analogies with which he is familiar. Emphasis is laid upon the fact that a man's "thinkery" is of even greater importance than his memory.

PERSONALS.

John Nixon, lately with the Buckley Electrical Company, is now in charge of the lighting plant at LaConner, Washington.

E. E. Burgess, manager of the Davenport Light & Power Company, of Davenport, Cal., was a San Francisco visitor during the week.

C. P. Platt, consulting engineer of the Home Telephone Company, returned to San Francisco last week after a business trip to New York.

Charles M. Hall, vice-president of the Aluminum Company of America, left Niagara Falls, accompanied by Dr. W. H. Hodge, and is visiting the Pacific Coast for his health.

R. A. Balzari, who has been for several years with the San Francisco office of the Westinghouse Electric & Manufacturing Company, is now covering Northern California as sales engineer.

A. D. Schindler, general manager of the Northern Electric Railway Company, whose leg was broken in an elevator accident last week, is resting easily at the Hahnemann Hospital in San Francisco.

Leon M. Hall and D. C. Demarest, together with Sidney M. Stone, A. C. Sprout, W. G. Morrow and W. C. Wallace, have opened offices in the Kohl Building, San Francisco, as Hall, Demarest & Co., engineers, making a specialty of mines, mills and power plants.

Jack Furness, who has been chief engineer for the Palace Hotel Company of San Francisco for the past thirty-seven years, has resigned. He had charge of both the Fairmont and Palace power plants. Assistant Engineer Trimble has gone from the Humboldt Bank Building plant to the Palace as acting chief.

H. A. Hageman has resigned as assistant superintendent of mechanical operations at the plants of the Niagara Falls Power Company and the Canadian Niagara Power Company, Niagara Falls, to accept a position with Stone-Webster Engineering Corporation to design and construct a power plant near Seattle.

W. H. Leffingwell, the engineer in charge of the Mono Power Company's hydroelectric construction work on the Owens River has arrived from Bishop, Nev., to confer with his principals in San Francisco. More than $150,000 has already been expended on the transmission project which will supply Tonopah and Goldfield with electric power.

Eeric H. A. Nordin, a hydraulic engineer who has been connected with the construction of several power plants for the Guggenheim interests in the Sacramento Valley region, has arrived from Marysville. He is en route to New York and will sail thence to Barranguilla, Colombia, where he is engaged to spend a year and a half in installing a power plant for the Guggenheims.

C. W. Stone, assistant engineer of the lighting department, and D. R. Bullen, manager of the supply department of the General Electric Company, Schenectady, are expected to arrive in San Francisco the second week in February to attend the annual agents' meeting for this district at the San Francisco office. They will also attend a similar meeting in Portland for the benefit of the agents in the Pacific Northwest.

SEATTLE SECTION A. I. E. E.

A. A. Miller has been elected chairman and W. S. Hoskins secretary and treasurer of the Seattle Section A. I. E. E. The selection of the executive committee has been postponed until a later date. A. A. Miller of the Westinghouse Company gave a lecture on Single Phase Railway Equipment, illustrated with stereopticon views. At the February meeting Renier Beeuwkes, assistant to Dr. Cary T. Hutchinson, will give a paper on the Cascade Tunnel Equipment.

ELECTRICAL MEN'S LUNCH CLUB OF LOS ANGELES.

At the regular monthly meeting of the Electrical Men's Lunch Club of Los Angeles, held January 13th, Mr. B. F. Pierson, general superintendent of the Southern California Edison Company, gave the members a very interesting talk on the development of the Edison Company in and around Los Angeles. Beginning about a dozen years ago with a second-hand boiler, engine and generator and coming down to the present time, touching lightly on each stage of development. Mr. Pierson stated the company had in prospect the building of another power plant on the Kern River, contemplating a 160,000 volt line. This point is particularly interesting, when considering the fact that less than 15 years ago certain prominent engineers insisted that even a 15,000 volt transmission line was impossible and had to be demonstrated in this particular locality before the practicability of such a line was possible. Mr. Pierson's remarks were thoroughly appreciated by the 64 members present and an earnest request made for an early return address. Mr. A. W. Ballard, local manager of the General Electric Company was elected chairman and Mr. Walton of the Southern California Edison Company vice-chairman, and Mr. R. B. Clapp of the Westinghouse Electric Company secretary for the ensuing year.

TRADE NOTES.

On February 1st the National Conduit & Cable Company will open offices in Los Angeles, with Mr. Walter Fagan in charge. Mr. Fagan has been purchasing agent for the Pacific States Electric Co.

The Lindsley Wright Company of Portland report a marked increase in the demand for long poles. Deliveries between January 1st and the 10th amounted to 2,500 poles. The supply is rather limited.

The Wire & Cable Company of Montreal announce that the Northern Electric and Manufacturing Company, Limited, 918 Pender street Vancouver, have been appointed sales agents for the Province of British Columbia.

The proposed consolidation of the Kellogg Switchboard & Supply Company with the Dean Electric Company, under the name of the Kellogg-Dean Electric Company, has not materialized, and all steps in that direction have ceased.

The Valley Power Company of Minneapolis, Minn., have ordered from the Westinghouse Company at Seattle a 550 k. w. generator, 30 k. w. exciter, three 200 k. w. transformers, switchboard, etc., for their plant at Cashmere, Washington.

The Portland Wood Pipe Company just closed a contract with the Post Falls Irrigation & Land Company of Coeur d'Alene, Idaho, to build five miles of continuous stave pipe line from Hayden Lake to the company's reservoir near Monoghan, Idaho.

Barnes Lindsley Company, the largest manufacturers of cross-arms on the Coast, have made several large shipments recently, and report the outlook for the coming year as being very favorable. They are preparing a large reserve stock in anticipation of the season's heavy demand.

The Pittsburg Testing Laboratory, inspecting and testing engineers, Pittsburg, are erecting a large 5-story fireproof office and laboratory building to house their rapidly growing business. They are represented on the Pacific Coast by Smith, Emery & Co., inspecting and testing engineers.

Kilbourne & Clark Company of Seattle have been awarded the contract of installing the electric motor drain pumping plant for the Columbia River Orchards Company at Priest Rapids. The plant will consist of four 300 h. p. units with a combined capacity of 40,000 g p. m. against a head of 83 ft. The machinery will be housed in a waterproof concrete structure which will be submerged during high water periods.

Kilbourne & Clark Co., electrical engineers of Seattle, Washington, have established a branch office and warehouse in Portland, with a large stock of electrical machinery, including Crocker-Wheeler apparatus and Wagner Mfg. Company's machinery. R. M. Vaughan is district manager with offices in the Couch Building.

H. V. Wilkenson and H. H. Thedinga formerly with the Canadian Westinghouse Company at Winnepeg and later with the Seattle Department of Public Utilities have formed a partnership as general consulting electrical and illuminating engineers with offices in the Central Building, Seattle, Washington.

Kilbourne & Clark Company of Seattle manufacture an inverted rotary converter for wireless telegraphy on shipboard. The Ceres, equipped with one of these converters, recently established a record for long distance, 4620 miles. The United States Government will investigate this converter with a view to adopting it for the Navy. It is remarkable for its efficiency and economy, 5 k. w. is the largest size required for any wireless equipment.

The General Electric Company through their San Francisco office has sold a 475 h. p. horizontal Curtis turbine direct connected to a Byron Jackson centrifugal pump for use on a plantation near Honolulu. They have also sold to the Key Route electric railway system of Oakland an additional 2700 k. w. railway generator set to be direct connected to Hamilton & Corliss engine furnished by Chas. C. Moore & Co., the present capacity of the station being 4700 k. w. in four units, two 1600 k. w., one 750 k. w. and one 650 k. w.

The Inland Empire Railway Company of Spokane have placed an order with the Westinghouse Electric Company of Seattle for a complete equipment of the second half of their power plant at Nine Mile, including two 3000 k. w. generators, two 3000 k. w. three-phase 6600-volt transformers, high tension switches apparatus, etc. The installation will be complete by June 1st. For their substation in Spokane they have placed with the Westinghouse Company an order for two 1500 k. w. synchronous motor generator sets, four 2000 k. w. 66,000 volt single phase transformers, switchboard and equipment. They have also ordered ten quadruple city car equipments.

Sanderson & Porter through their San Francisco office report that they have closed a contract with Milliken Bros. of New York for special steel tower extensions aggregating 300 tons in weight for the transmission line of the Sierra & San Francisco Power Co. These are to be installed at crossings at Alviso, San Joaqnin river and various sloughs on their line. There are 27 of these extensions, some of which are 87½ ft. high and on which the standard 50 ft. towers, supplied by the Aeromotor Company will be erected, giving a total height of 132 ft.; the remainder will be 62½ ft, high, giving a total height of 112½ ft. The standard spans are maintained so that the crossings will not exceed 750 ft. except at the Alviso crossing.

The Kellogg Switchboard & Supply Company's reputation for quick delivery of the very highest class work on rush switchboard and telephone orders is well known. Recently two rush orders for switchboards replacing fire losses at Lamar, Mo., and Bath, Michigan, were completed and delivered on record time. Quick deliveries by this company, as their customers will appreciate, do not mean carelessly put together apparatus, but the standard built Kellogg exchange. At the close of the year two more telegraph orders for switchboards replacing boards destroyed by fire were received. One for Dardanelle, Arkansas, for one 300 line, two position magneto switchboard with 200 lines equipped—two operators' sets and 20 cord circuits. The other from the Hollandale Telephone Company, Hollandale, Wisconsin for one 100-line magneto switchboard.

NEWS OF THE STATIONARY ENGINEERS

PREAMBLE.—This Association shall at no time be used for the furtherance of strikes, or for the purpose of interfering in any way between its members and their employers in regard to wages; recognizing the identity of interests between employer and employe, and not countenancing any project or enterprise that will interfere with perfect harmony between them.

Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the business of the Association, and at all times preference shall be given to the education of engineers, and to securing the enactment of engineers' license laws in order to prevent the destruction of life and property in the generation and transmission of steam as a motive power.

California.

No. 1. San Francisco, Thursday, 172 Golden Gate Ave. Pres., P. L. Ennor. Sec., Herman Noethig, 816 York St.

No. 2. Los Angeles. Friday, Eagles' Hall, 116½ E. Third St. Pres., J. F. Connell. Cor. Sec., W. T. W., Curl, 4103 Dalton Ave.

No. 3. San Francisco. Wednesday, Merchants' Exchange Bldg. Sec., David Thomas, 914 O'Farrell St.

No. 5. Santa Barbara. Geo. W. Stevens, 2417 Fletcher Ave., R. R. No. 2.

No. 6. San Jose. Wednesday. Pres., W. A. Wilson, Sec., Lea Davis, 350 N. 9th St.

No. 7. Fresno. Pres., A. G. Rose. Sec., E. F. Fitzgerald, Box 651.

No. 8. Stockton. Thursday, Masonic Hall. Sec., S. Bunch, 626 E. Channel St. Pres., H. Eberhard.

Oregon.

No. 1. Portland. Wednesday, J. D. Asher, Portland Hotel. Pres., B. W. Slocum.

No. 2. Salem. A. L. Brown, Box 166.

Washington.

No. 2. Tacoma. Friday, 913½ Tacoma Ave. Pres., Geo. E. Bowman. Sec., Thos. L. Keeley, 3727 Ferdinand St., N., Whitworth Sta.

No. 4. Spokane. Tuesday. Pres., Frank Teed. Sec., J. Thos. Greeley, 0601½ Cincinnati St.

No. 6. Seattle. Saturday, 1420 2d Ave. Pres., H. R. Leigh. Sec., J. C. Miller, 1600 Yesler Way.

Practical letters from engineers and news items of general interest are always welcome. Write your items regardless of style. Communications should be addressed to the Steam Engineering Editor.

PRACTICAL MECHANICS, PAPER NO. 5.

Having covered in the preceding papers the elementary analysis of uniplanar motion, we will now proceed to the study of the various forms of machines for transmitting motion. It is to be remembered that we have in mind at present only the transmission of pure rotation. Referring to the table in paper No. 1, we shall first consider the fourth method of transmission—that by link-work.

We are taking up the link-work transmission, or transmission through a rigid intermediate member first, because it is simpler in application than are the other forms to be considered, and because it is the most efficient of all forms of transmission. This high efficiency is possible because the resistance due to friction is only that of small pins in well lubricated bearing holes, and there are usually fairly long arms with which to turn these pins. Furthermore the pins never make but one revolution for each turn or cycle of the machine and often but a fraction of a complete revolution; while in the corresponding movement of a cam motion, for example, the roller makes from six to twelve turns. Link-work is, therefore, much more durable and positive than other forms of mechanism. The possible variations in the application of link-work are, however, few, their movements being among the most arbitrary laws of motion and for this reason it must in many cases be abandoned where it would otherwise be preferable. It is usually best therefore to consider a proposed link-work movement complete, and if found unsuitable attempt another, rather than to assume the law of motion and endeavor to make the link-work conform to such law.

In applying a rigid intermediate members to transmit rotation from one body to another, the possible cases are:

1—*Axes of rotation parallel*, either in the same straight line or otherwise.

2—*Axes of rotation intersecting*, without meeting.

3—*Axes of rotation crossing*.

We shall consider these cases in the order named.

Axes of rotation parallel—Where the axes of the two rotating parts are in the same straight line, there is necessary merely an axle or shaft to rigidly connect the parts. This, of course, at once fixes not only the condition that both parts shall turn with the same angular velocity, but it requires further that the angular velocity at all points of any revolution be the same for both members.

The important considerations in the particular case of axes in line is rather one of journal bearing and shaft design. As it is not the purpose of these papers to go into machine design the reader is left to consult some good work on the subject.

Taking now, the more general case of axes, parallel and not in the same line, we come to the most useful and familiar form of link-work.

The well known locomotive side-rod is a good example. This application necessitates that both pins of attachment be located at the same distance from their respective centers of rotation, otherwise complete revolution is not possible. It is to be noticed also that when the two pins are in line with the two axes of rotation the motion is not constrained. This condition is provided by the addition of a second rod and set of pins or cranks placed at some angle, other than zero or 180 degrees with the first pair of pins. It is usual to place this second set of pins at an angle of 90 degrees with the first set, as the strains on the entire mechanism are thereby reduced. Where the parallel axes are not far out of line a useful form of coupling is that known as the Oldham coupling. Two dotted disks at the end of each shaft, are connected by an intermediate disk provided with raised prismatic guides, which fit the respective stops. These guides run diametrically across each face of the disk and are best placed at right angles to each other. This form of transmission is much less efficient than the intermediate rod and pins would be. It will usually be found, too, that, where the axes are nearly enough aligned to permit of the use of this form of coupling it will be possible to exactly line them up and use a direct coupling.

A certain form of the universal joint is applicable to the transmission of rotation between parallel shafts, but as this is a special case of the general application of the universal joint, it will be described after the general case is discussed under intersecting axes.

TRADE NOTES.

The Yale Laundry at Portland will increase its power plant, adding an engine and generator set.

The Whatcom Railway & Light Company have ordered 2000 k. w. Curtis turbine generator and 3500 h. p. Pelton water wheel to be installed at Bellingham, Wash.

The Standard Lumber Company at Deer Park, Washington, have equipped their mill with 500 h. p. Curtis turbine generator set and individual motor drive for each machine.

The British Columbia Electric Railway Company has placed an order with Allis-Chalmers Company for two 2000 k. w., 1800 r. p. m., 60 cycle, 3-phase condensing steam turbo generator units. These will be used in connection with extension of the service.

The Weed Lumber Company of Weed, California, is arranging to drive much of the machinery it uses with motors and has ordered a 750 k. w., 3600 r. p. m., 60 cycle, 3-phase, 600 volt condensing steam turbine unit from Allis-Chalmers Company to supply the necessary power.

The new power plant being installed at St. Vincent's Hospital of Portland, Oregon, includes a boiler battery of 210 h. p., two American Ball engines, one 100 h. p. and one 75 h. p.; two Westinghouse 3-wire generators, 50 and 75 k. w. The power house is of brick and has a concrete stack 155 ft. high and 54 in. in diameter. The plant is equipped with a Webster vacuum system, Johnson heat regulating system, electric elevators, modern laundry plant, and cold storage units on every floor.

INDUSTRIAL

GAS-ELECTRIC MOTOR CARS.

A brief description of the gas-electric motor cars recently purchased by the Southern Railway Company from the General Electric Company, and now under construction, should prove of interest to the many steam railroads which operate similar service. As shown in the cutline views these cars have been designed with special reference to traffic conditions in the South. The car is divided by a center entrance. The seating capacity forward of this entrance is 14, and to the rear is 38, making a total seating capacity of 52 passengers. A rear entrance is also provided, thus completely dividing the forward and rear passenger compartments.

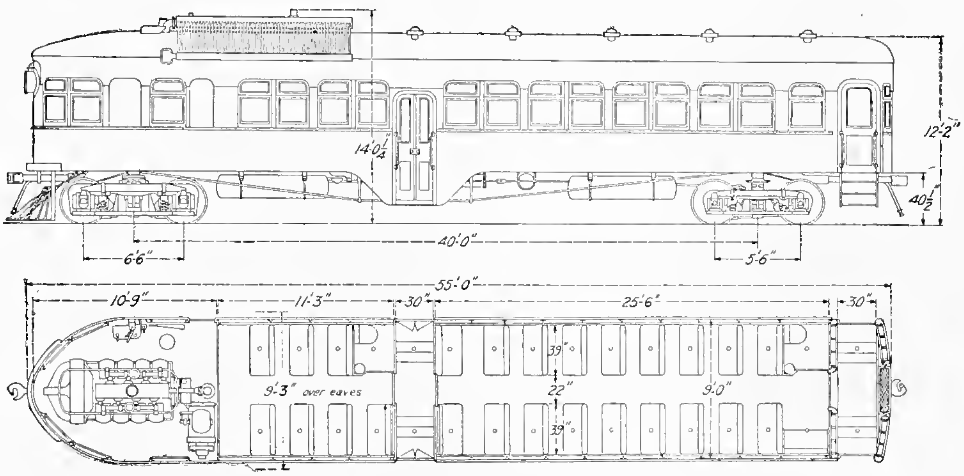
The car body is 55 ft. long over bumpers, and of this space the engine compartment will take up 10 ft. 9 in., leaving the balance for passengers and platform. The car will be constructed of steel frame work and sheathed with steel plates, the interior trim being of mahogany.

gas engine is also direct connected to a generator for lighting the car.

Combined straight and automatic air brakes will be furnished, together with the usual auxiliary apparatus and in addition to these brakes an auxiliary ratchet and hand brake is part of the equipment for emergency use. A radiator is placed on the roof of the car which provides an efficient means of cooling the engine on the thermo-siphon principle. During the cold weather, hot water from the engine circulating system will be by-passed through the passenger compartments.

Although these cars can be geared for a speed of about 60 miles an hour on tangent level track, such speeds are not usually required on branch line service and the Southern Railway cars will be geared for a somewhat lower maximum speed.

The ease of control and smoothness of acceleration are prominent features of this type of equipment and are secured



Outline View of Gas-Electric Motor Car.

The truck under the engine compartment will have a wheel base of 6 ft. 6 in. and will be equipped with M. C. B. 33 in. steel wheels. On each axle of this truck will be mounted standard 100 h. p. 600 volt box frame, commutating pole, railway motor, type GE-205, thus giving the car a motor capacity of 200 h. p. The rear truck will have a wheel base of 5 ft. 6 in.

In the engine compartment there will be a direct driven gas engine generator set, the engine being of the 8-cylinder "V" type, each cylinder 8 in. in diameter by 8 in. stroke. Direct coupled to this engine will be an 8-pole 600 volt generator provided with commutating poles. This set will be mounted on a cast iron base, and all parts will be above the floor line and readily accessible. Current from the generator will be supplied to the motors through a controller, the function of which is to place the motors progressively in series and parallel and to vary the resistance in the shunt field of the generator by means of numerous steps, thereby varying the impressed voltage on the motors. The engine ignition is furnished by a low tension magneto and magnetic spark plugs. The carburetor is of the over-flow type and hot water jacketed. Compressed air is used for starting the engine, this being supplied to the several cylinders in succession through a distributing valve. Compressed air is supplied from a pump direct driven by the main crank shaft. A small auxiliary gas engine will drive an auxiliary pump to supply compressed air to the main reservoirs when necessary. This

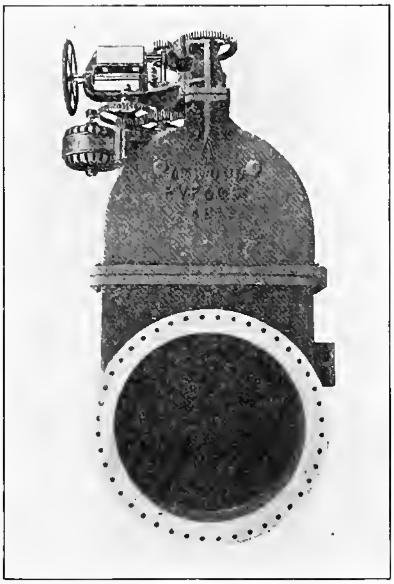
solely by reason of the gas-electric drive principle which it embodies. As there is no mechanical transmission between the engine and the axle, the speed of the engine is not a function of the speed of the car, consequently, the gas engine may be operated so as to give its maximum output irrespective of the speed of the car—a characteristic which is of great value in case of emergency or heavy work. It has been found that the electrical equipment, consisting of the generator, controller and motors and which takes the place of the gears, chains, sprockets, clutches and other mechanical means of transmitting the power of the gas engine to the axle, is subject to very little maintenance expense and the efficiency of this electric drive is high. The feature, perhaps, which will most strongly appeal to railway men is the simplicity of this control and the ease and certainty with which it can be handled by an ordinary unskilled operator.

KLEIN'S METAL POLE SUPPORTERS

Have the advantage of lightness and strength, smaller diameter of the uprights, which makes them more convenient to handle, and allowing the follow-up-man to work with more agility than with the wooden pattern. Furthermore, being of metal, they are not warped and twisted and weakened by exposure to the weather, and consequently are indestructible. The flange at the foot prevents the support from sinking into soft ground. Made in the customary sizes, 6-foot, 7-foot and 8-foot.

A LARGE ALTERNATING CURRENT MOTOR OPERATED GATE VALVE.

The large alternating current motor operated gate valve shown in the accompanying illustration is installed at the plant of the Pressed Steel Car Company, McKees Rocks, Pa., where it is inserted in the exhaust line from a 1000 k. w. Westinghouse low-pressure turbo-generator to the condenser. The valve closes upon a clear opening 48 inches in diameter, and is operated by a 3-horsepower, three-phase, 60-cycle, 550-volt Westinghouse type "CCL" induction motor. The motor speed of 1120 r. p. m. is reduced through suitable gearing to the speed of the main operating thread, proper for closing the valve safely and quickly. A hand wheel for hand closing is also provided. A worm gear on one of the intermediate shafts operates a limit switch mechanism, which automatically controls the movement of the gate by stopping the motor at a certain point in the gate travel either way.



A. C. Motor Operated Gate Valve.

To open or close the valve, it is thus necessary only to throw the operating switch into the corresponding position, starting the motor which continues to run until it is automatically cut off when the end of the valve travel is reached. The valve is thus operated with the absolute minimum of effort or trouble, and can be closed or opened at the predetermined safe operating speed as easily as switching on an electric light. The limit switch which accomplishes this automatic control is enclosed in the box shown at the right of the valve gear. The operator's switch, by which the valve is opened or closed, may be located in any convenient position about the building or plant.

The assembly of the motor and gearing in the instance shown was a special construction made necessary in clearing neighboring pipes and walls. Applications of alternating current motors for control services of this kind are yet in the classification of novelties, but the excellent performance of this apparatus has demonstrated that the induction motor is rapidly coming to occupy the wide field in which the direct current motor has already proven so pre-eminently the ideal motive power. The 48-inch gate valve illustrated was designed and built by the Pittsburg Valve Foundry and Construction Company, Pittsburg, Pa., and the motor and limit switch device were furnished by the Westinghouse Electric and Manufacturing Company.

NEW CATALOGUES.

Bulletin No. 4712 from the General Electric Company contains interesting data on the exhaust steam turbine.

Bulletin No. 53 from the Kellogg Switchboard & Supply Company illustrates and describes their multiple switchboards, presenting many valuable and interesting details of construction and installation.

The General Electric Company's Bulletin No. 4711, recently issued, treats of switchboard panels designed for small a. c. plants. The bulletin lists panels for two-phase and three-phase circuits, shows the connection diagrams for such panels, and gives dimensions and capacities.

The Rauch & Lang Carriage Company of Cleveland, Ohio, have issued their 1910 announcement of R. & L. electric carriages. This catalogue is of unusual size, its large pages readily lending themselves to an illustration and complete specification for each type of car described.

Bulletin No. 4713, recently issued by the General Electric Company, describes its Type F, Forms K-2 and K-4 Oil Switches, states their rupturing capacities contains diagrams of connections of those switches, and will be found of general interest to certain station managers and engineers.

The Garvin Machine Company, Spring and Varick streets, New York, N. Y., have issued an illustrated catalogue containing descriptions of hand lathes, spring coilers, cutter grinders, surface grinders, milling machine tools and attachments, screw machine tools and attachments, friction pulleys, countershafts, cone pulleys, hangers, and valuable tables of information.

In Bulletin No. 4706 recently issued by the General Electric Company is illustrated and described the company's type CR Curve-Drawing Ammeters and Voltmeters. This type of instrument gives a clear permanent record of the characteristics of the electric circuit to which it is applied and will be found of value in locating trouble with electrical apparatus in proving the efficiency of machines and workmen especially where the individual drive system has been adopted and in determining the correct size and style of the new machine. This instrument is suitable for use on either alternating or direct current.

The General Electric Company in Bulletin No. 4703-A, recently issued, describes its Variable Release Air Brake Equipment, which eliminates the defects usually found in the standard automatic air brake equipment for electric service. With the variable release equipment it is possible to handle a long train with nearly the same facility as single cars can be handled with the straight air brake system. The bulletin goes into considerable detail in describing this equipment, and shows cross sections of the valve when in different positions. This publication should be of interest and value to railroad men.

Gasolene-Electric Plants for Lighting and Power is the title of a very attractive publication just issued by the General Electric Company, which should be of great interest to those contemplating the installation of a small or isolated plant, or to those having country homes that are not within reach of the distributing circuit of a central station. As indicated by the title the pamphlet illustrates and describes complete generating units consisting of a direct current generator mounted on the shaft of a gas engine. These sets are attractive and are described in considerable detail. The pamphlet shows pictorially a number of the many uses to which current from such a set can be put. The number of the publication is 4707.

The Inland Portland Cement Company of Metaline, Washington, will install a plant consisting of two units, 1750 k. w. each, driven by Pelton water wheel.

NEWS NOTES

FINANCIAL.

GLENDALE, CAL.—The Trustees have voted to sell $14,-000 worth of bonds to provide for the completion of a lighting department.

OAXACA, MEX.—Bonds for the new sewerage and water works system, amounting to one million eight hundred thousand pesos have been signed.

SAN JOSE, CAL.—The stockholders of the San Jose Railroad, the corporation which recently merged the street railways in this city, except the Interurban, have decided to issue bonds to the amount of $1,500,000.

HOLTVILLE, CAL.—The City Council has passed an ordinance calling an election to vote on the question of incurring an indebtedness in the sum of $37,000 for acquisition of water rights and the completion of waterworks. The election is to be held on January 28th.

BRAWLEY, CAL.—Sealed bids will be received until February 5 by the City Board of Trustees for the purchase of $44,000 of bonds voted December 28th for waterworks, etc. The bonds will be dated January 1, 1910, and bear interest at the rate of 5½ per cent per annum.

PHOENIX, ARIZ.—The Council of Tempe, Arizona, has memorialized Congress to permit the bonding of the town to permit construction of an electric lighting system to cost $25,000, to be ready for operation within two years when the present contract with Chandler will expire.

NEWPORT, CAL.—The City Council has passed an ordinance providing for the issuance and sale of bonds of the city in the sum of $65,000, $25,000 of which is to construct municipal light works and $40,000 for construction of water works for the city. The bonds will be of $1000 each and bear 5 per cent interest per annum.

INCORPORATIONS.

SEATTLE, WASH.—The Washington Fir Crossarm Company, capital $30,000, has been incorporated by W. M. Carpenter, John H. Neville and Ernest S. Hough.

RIVERSIDE, CAL.—The Moreno Water Company has been incorporated with a capital stock of $50,000, by D. S. Hayward, E. C. Bennett, J B. Maxwell and J. R. White.

ELBERTON, WASH.—The Elberton Milling & Power Company has been incorporated with a capital stock of $60,000 by Charles Hinchliff, Fred Hinchliff and Floyd Hinchliff.

NORTH YAKIMA, WASH.—Articles of incorporation of the Wenas Electric Power Company have been filed, with a capital stock of $15,000, by F. V. Sanders, L. J. Anderson, P. C. Weinman, M. B. Miles and E. G. Townsan. The company intends to build a power line into Wenas and supply power for pumping water for irrigation from the artesian wells of the valley.

PORTLAND, ORE.—Articles of incorporation of the Hood River Light & Power Company with a capital stock of $2,000,-000, have been filed here. The papers provide for the construction of an electric railway from the mouth of Hood River to a point in the Mt. Hood District. Head offices are to be here, and the incorporators are: John D. Wilcox, a Portland real estate man; Wirt Minor, of the law firm of Teal & Minor, and R. Smith.

HONOLULU, H. T.—It has been practically decided by the directors of the Kauai Railway to issue $500,000 of 6 per cent 10-20-year bonds for the purpose of taking up the old issue and building the company's terminal at Port Allen. Of the old 6 per cent bond issue only about $80,000 were floated. These are to be taken up, or replaced by the new issue. The balance of the money is to be used for the company s terminal and other important improvements at Port Allen. George R. Carter says: "The scheme of improvements to be carried out, and for which the money is required, will greatly enhance the value of the road. This enterprise, by the way, is a going concern. That is to say, it already has the business and opportunities right at hand for much larger things. We are in urgent need of proper facilities at Port Allen, and the scheme now under way will fill the bill. The issue of bonds will be $500,000 and the rate will be 6 per cent. The bonds may be taken up any time after ten years and expire in 20 years."

TRANSMISSION.

PORTLAND, ORE.—The Oregon, Electric Company recently added a 500 k. w. rotary converter at Multnomah substation.

ENTIAT, WASH.—The Entiat Light & Power Company, Frank McKean, engineer, will put in two 1500 k. w. generators and water wheels.

SPOKANE, WASH.—The Big Bend Water Power Company, Paulsen Building, will build a 20,000 h. p. electric plant on the Spokane river 30 miles below the city.

DIXON, CAL.—Sealed bids will be received up to March 1st, at 8 p. m. for a franchise to erect poles and set wires for transmitting electricity along streets of this town.

CENTRALIA, WASH.—The Tenino Power & Water Company has made application for a franchise over the county roads of Lewis county for the purpose of telephone, telegraph and electric lines.

WALLA WALLA, WASH.—R. A. Stephenson of Mason City, Iowa, and C. E. Buell of Webster City, Iowa, contemplate building a large power plant on the Columbia river and are negotiating with prospective customers for power.

KENNEWICK, WASH.—The Yakima Valley Power Company will, according to report, connect this place and Pasco by means of a cable spanning the Columbia river and will for this purpose construct three 150 ft. steel towers.

PLACERVILLE, CAL.—T. A. Murray has filed notice of location and appropriation of 10,000 inches of water in Camp creek, flowing into the North Fork of the Cosumnes river. The location is for power, municipal irrigation and mining purposes.

CHICO, CAL.—According to A. W. Smith, secretary of the Sacramento Valley Power Company, that company will commence planting the poles for its distribution system in Chico during the present week. It is believed that the work can be completed within 30 days. Men have been engaged and the poles are now awaited.

OAKLAND, CAL.—The People's Electric Light & Power Company has filed a revised application for a franchise for electric transmission lines through the county of Alameda, and for the conducting of electricity for furnishing heat and power. The changes in the previous application were made necessary by the annexation election.

COTTAGE GROVE, ORE.—The Postal Telegraph & Cable Company, through its agent, H. M. Smith of Chicago, is contracting in this territory for 26,000 telegraph poles for the line across the continent from San Francisco. After this order is filled contracts will be made for poles to build a two wire line from San Francisco to Portland and Seattle.

RED BLUFF, CAL.—A notice of an appropriation of 15,000 inches of water in Cottonwood creek has been filed in the county recorder's office by the Rancho Buena Ventura. The real locator is Geo. L. Hoxie, one of the owners of the Rancho. The water is to be used on the northeast quarter of the northwest quarter of section 16, township 29 north, range 4 west, for irrigating purposes and generating electricity.

SEATTLE, WASH.—The Seattle Electric Company have completed and put in operation their new sub-station at Ballard. The equipment consists of two motor generator sets, one 500 k. w. and one 1000 k. w. and two 1000 k. w. transformers 13,000 to 22,000 volts. The new sub-station furnishes a. c. for power, d. c. for light and railway distribution. The company will change the 13,000 volt transmission line between Ballard and Everett to 60,000 volts. The company's new office building at Seventh and Olive streets, Seattle, will be ready for occupancy some time in April.

SACRAMENTO, CAL.—The Sacramento Gas, Electric & Railway Company is receiving material for the work of constructing conduits under the streets to replace the overhead wire system, in the part of the city lying between Fifth and Seventh, I and L streets. The district in which electric wires must be laid underground extends from Front to Twelfth, from I to L streets. This district is divided into three sections, one section to be cleared of overhead wires in 1910, the second section in 1911, and the third in 1912. The work will be under the charge of G. C. Holberton of the Pacific Gas & Electric Company.

REDDING, CAL.—W. D. Tillotson, attorney for the Mount Shasta Power Company, has filed six deeds and eleven agreements and assignments. One of these deeds is a transfer to the corporation of a water right of 200,000 inches of Pit river, in the Big Bend country. It is proposed to divert all this water through a tunnel seven miles long. This is H. V. Gates' project. By the papers filed H. V. Gates, R. E. Johnson and A. J. Treat consolidate their various interests in a corporation with a capital stock of $1,000,000. It is evident that the Mount Shasta Power Company is getting into a position where the active work of construction will be begun. The project involves the expenditure of several million dollars, and it will be one of the biggest undertakings of the kind on the Coast. The Big Bend of the Pit makes a 25-mile detour. The 7-mile tunnel will convey the whole river through the mountains and at its outlet will deliver water with such a great fall that 250,000 h. p. can be developed electrically.

TELEPHONE AND TELEGRAPH.

MEDFORD, ORE.—Estimates are being prepared for the construction of a telephone building for the Home Telephone Company.

VALE, ORE.—W. D. Baker has been granted a right of way by the county court for a telephone line over certain country roads.

LAMONT, WASH.—W. R. Hegler of this place has organized a telephone company and will also install an electric light system here.

VIRGINIA, MONT.—The Montana Independent Telephone Company has been granted a franchise by this place and work is to begin on the new plant at once.

WALLA WALLA, WASH.—Chas. Springer and others are interesting themselves in the project of building a telephone line between this place and Touchet.

MEDFORD, ORE.—Frank C. Clark, architect, of Ashland, is preparing plans for the building to be erected for the Independent Telephone Company.

MEDFORD, ORE.—The Medford & Butte Falls Telephone Company, B. H. Harris, has made arrangements with the Pacific Telephone Company to build to Central Point.

CRANBROOK, B. C.—The Kootenay Telephone Company will in the spring build from here to Kingsgate, where connections will be made with the Rocky Mountain Bell Company.

ASHLAND, ORE.—In celebration of the completion of direct telegraph communication between Ashland and Klamath Falls, city officials have sent greetings to those of the Klamath county capital.

IRONDALE, WASH.—The Sunset Telephone Company will put in an exchange here, also one at Quilcene. The improvements to be made by the Sunset in the country districts will amount to $6,000 to $8,000.

WINNEMUCCA, NEV.—J. E. Webb of the Golconda Telephone, Light & Power Company, accompanied by F. Murray has been in town completing arrangements to install a switchboard and local telephone system here.

BURNS, ORE.—The Union Telephone & Telegraph Company has been incorporated, with its principal office at Burns; capital stock $5000. incorporators: J. H. Jordan, John Jenkins, C. H. Voegtly and L. E. Laurance.

CERES, CAL.—The Ceres Telephone Company contemplates beginning work in a few days on the extension of its system toward the Crows Landing road country. It is reported this extension will include five miles of wiring.

SEATTLE, WASH.—The Home Telephone Company of Seattle are making extensive additions to their central switchboard and putting in a new long distance switchboard of the most modern construction. They are also enlarging their switchboard at Green Lake Station to care for increased business.

TWIN BRIDGES, MONT.—An ordinance has been passed granting the Montana Independent Telephone Company the right to enter the town and it is understood that work will be commenced at once extending the line from Whitehall to this place and thence to Dillon. It is also reported that a branch will be built up the valley to Sheridan and Virginia City.

ILLUMINATION.

NEWCASTLE, CAL.—An election will be held February 3d to decide whether a public highway lighting district shall be formed, as provided by the recent act of the Legislature.

VALLEJO, CAL.—Improvements involving the expenditure of $60,000, which, when complete, will make the local gas works the finest in any city of this size in the State, have been begun by the Pacific Gas Company.

SANTA BARBARA, CAL.—It has become known that the Edison Company will spend $211,000 for a new gas plant, four times the size of the present one. About $150,000 more will be devoted to the extension and improvement of the local trolley system.

VENICE, CAL.—Merchants of Venice have taken the initiative in a movement to organize a local corporation to establish an independent gas system. J. M. White, E. W. Smith and Thomas Taylor have started out to sound public sentiment. They will report back at the meeting in two weeks.

REDLANDS, CAL.—H. B. Duncan, secretary of the San Bernardino Valley Gas Company, states that the company will construct a generating plant at Colton to manufacture gas to be used in Colton, Redlands, and at the San Barnardino plant. Should it be advisable the company will construct a high pressure line from Colton to Corona.

SAN RAFAEL, CAL.—The gas company has received a large consignment of pipe from the East and has it stored in Ross. The gas company will in the near future extend its gas mains from San Rafael to Ross and probably further. San Anselmo was the first town to sign up for gas and therefore will be the first to have the connections made.

TRANSPORTATION.

OSWEGO, ORE.—The Portland Light & Power Company will construct a line from West Oregon City to Oswego a distance of four miles.

PORTLAND, ORE.—Standard gauging of two miles of street railway in East Portland is under consideration by the Portland Railway, Light & Power Company and will probably be ordered in the near future.

REDONDO, CAL.—The announcement that the Pacific Light & Power Company is soon to double the capacity of its big plant here has renewed the report that the Los Angeles and Redondo Railway will extend its line south to San Pedro. A right of way has been secured.

WOODLAWN, ORE.—The Valley Railway Company has just completed three miles of track between Woodburn and West Woodburn connecting with the Oregon Electric Railway at the latter place. The new line will be operated about February 1st by the Oregon Electric Company.

OAKLAND, CAL.—The Supervisors have received and filed with the roads, bridges and franchise committee an application from the Southern Pacific Company for a franchise to construct and operate an electric railroad from Albany to Berkeley as part of its present interurban railroad system between Berkeley and San Francisco.

SACRAMENTO, CAL.—Nine suits for rights of way for the line to be run between Lodi and Sacramento have been filed by the Central California Traction Company. The property owners are J. W. Reynolds, A. J. Neves, R. J. Neves, C. M. Dillard, J. L. Martin, Kate Costella, Ugo Pechler, James Soukup, T. Ikedo and T. Sato. Their property lies in Goethe Colony No. 13.

SAN FRANCISCO, CAL.—The San Francisco Board of Supervisors have passed the vote with the approval of Mayor Taylor to grant a franchise for a term of 25 years over Gough street from McAllister to Market and Haight to the United Railroads Company. The railway company desired this franchise for the purpose of a route which would avoid the Fillmore street hill.

LOS ANGELES, CAL.—Within ten days grading for the Pacific Electric Railway will be completed through Claremont, then rails will be laid connecting that city with Upland. The Pomona right of way committee has effected a compromise with the orange growers at North Pomona through whose grove the line is to be laid, with the exception of one ranch. When this is adjusted there will be nothing to hinder the completion of the main line to Covina.

FRESNO, CAL.—The Supervisors have received application from the San Francisco firm of Gilmore & Lennon for a franchise to construct and operate a railroad between here and Coalinga. This is the third of the kind within three months. A direct route from Fresno to Coalinga has been a favorite topic of discussion among local capitalists ever since the wealth of Coalinga oil fields was demonstrated. At present the old town can be reached only by one route, the Southern Pacific, and the distance is 100 miles. This would be cut to 60 miles if the proposition now being advanced are carried out.

MEDFORD, ORE.—The Rogue River Valley electric line operated between Medford and Jacksonville, is to be extended from Jacksonville to Applegate Valley next spring; $125,000 is now being provided by bond issue placed with the Merchants' Loan and Trust Company of Portland, at 5 per cent interest. The road is owned by W. S. Barnum & Sons. Survey of the route has been made across the divide between Jackson Creek and Applegate River, the heaviest grade being 2.3 per cent route up Jackson Creek for two miles from Jacksonville, at which point it will cross the divide to Poorman Creek, and will terminate at Ruch for the present.

OAKLAND, CAL.—That the plans of the Southern Pacific Company to extend its electric system from Alameda to San Jose will be put in operation as soon as the lines on the east side of the bay are electricized is announced by a prominent railroad official. According to the official's information, the Southern Pacific Company will make use of the old narrow-gauge right of way across Bay Farm Island to the mainland, thence down the east side of the bay to San Jose. The right of way is owned by the railroad. A portion of the trestle is still intact and the roadbed is in good condition across the island and needs only tracks of standard gauge to make it suitable for traffic.

WATERWORKS.

LODI, CAL.—The Trustees have decided to construct a municipal water plant.

BEVERLY, WASH.—Bates & Clark, engineers of Seattle, Wash., are putting in a 200 h. p. steam pumping plant for the Rose Land Company at Beverly.

SILVER CITY, N. M.—The Silver City Valley Water Company of this city has let a contract for sinking of a 500 foot 12-inch well just north of town.

SAN FRANCISCO, CAL.—Sealed proposals, in triplicate, will be received at Fort Mason up to 11 a. m. February 1, 1910, for constructing water and sewer systems, including grading around officers' quarters at Presidio of San Francisco.

VALE, ORE.—A contract has been entered between the city of Vale and Parrott, Cottrell & Parrott of Baker City, in which the city employs these engineers to make surveys, draw plans, mark the surveys on the ground, find the best water supply, and make estimates for a complete water system.

EVERETT, WASH.—A move for municipal ownership of the water system has been begun by Councilman Phillips, who has introduced a resolution instructing the mayor to appoint three members of the City Council and the city engineer to investigate the cost and employ a reliable engineer to secure a source of supply and plan a system of mains, etc.

PORTERVILLE, CAL.—At a meeting of the Rosedale Water Company held on January 12th, the following members of the company were chosen for the board of directors: J. A. Milligan, E. L. Sloan, F. D. Bailey, B. L. Carpenter, J. H. Orr. The directors organized and chose for the year, J. A. Milligan as the president and E. L. Sloan as the secretary.

SACRAMENTO, CAL.—The East Sacramento Water Company plans a meeting to decide on a site for its wells, to get bids for boring, select plans for towers, buildings and other adjuncts and to discuss getting a franchise from the county. The company hopes to supply water, gas and electricity to East Sacramento and other outside sections, but not to Sacramento.

GRASS VALLEY, CAL.—Announcement is made that the South Yuba Water Company is ready to carry out the promise given a year ago relative to piping and fluming water through certain sections of the ditch now supplying the city reservoirs, thus giving the town a supply of pure water. City Engineer Miller will shortly go over the ditch in question and map the portions where pipes or flumes are necessary.

CENTRALIA, WASH.—The Centralia-Chehalis Water & Power Supply Company has filed articles of incorporation, for the purpose of constructing a pipe line conveying water from the Newaukum river to the water supply systems in Centralia and Chehalis, thus giving the two cities gravity water plants. The cost of the line will be $200,000. The officers of the company are John E. Heasty, L. W. Goodrich, E. S. Prico, F. S. Blarner, Clayton W. Quale.

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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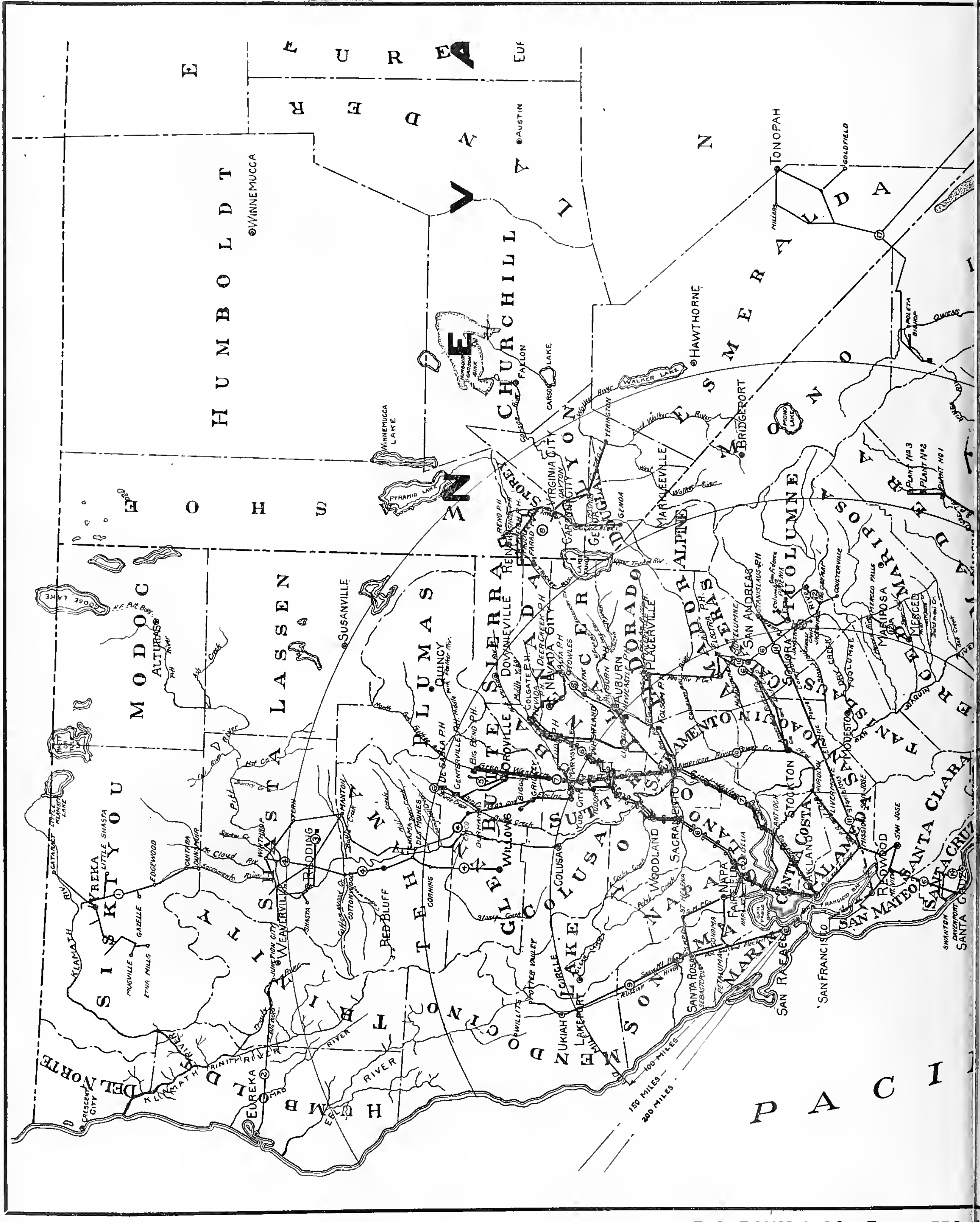
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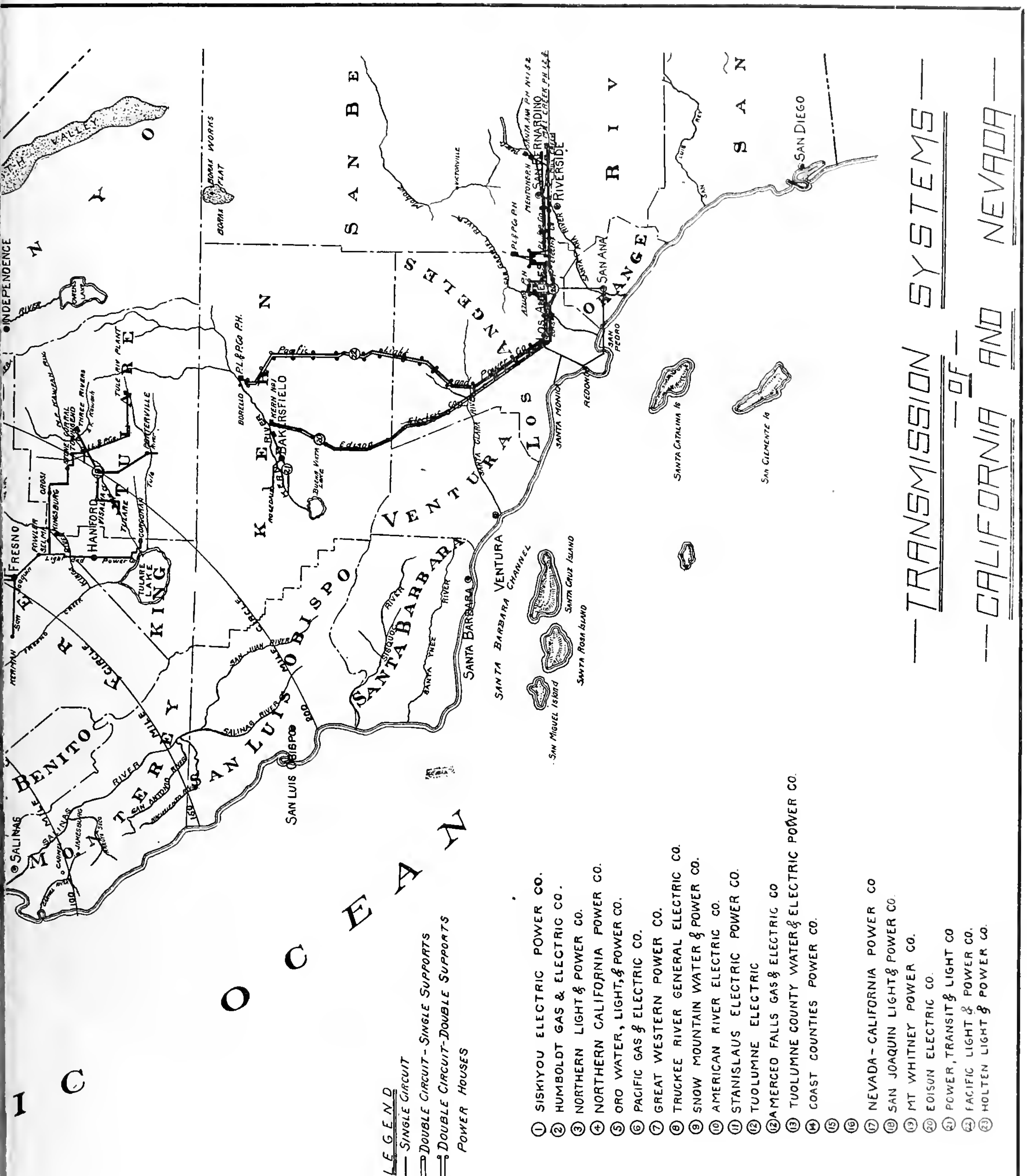

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Journal of Electricity
POWER AND GAS
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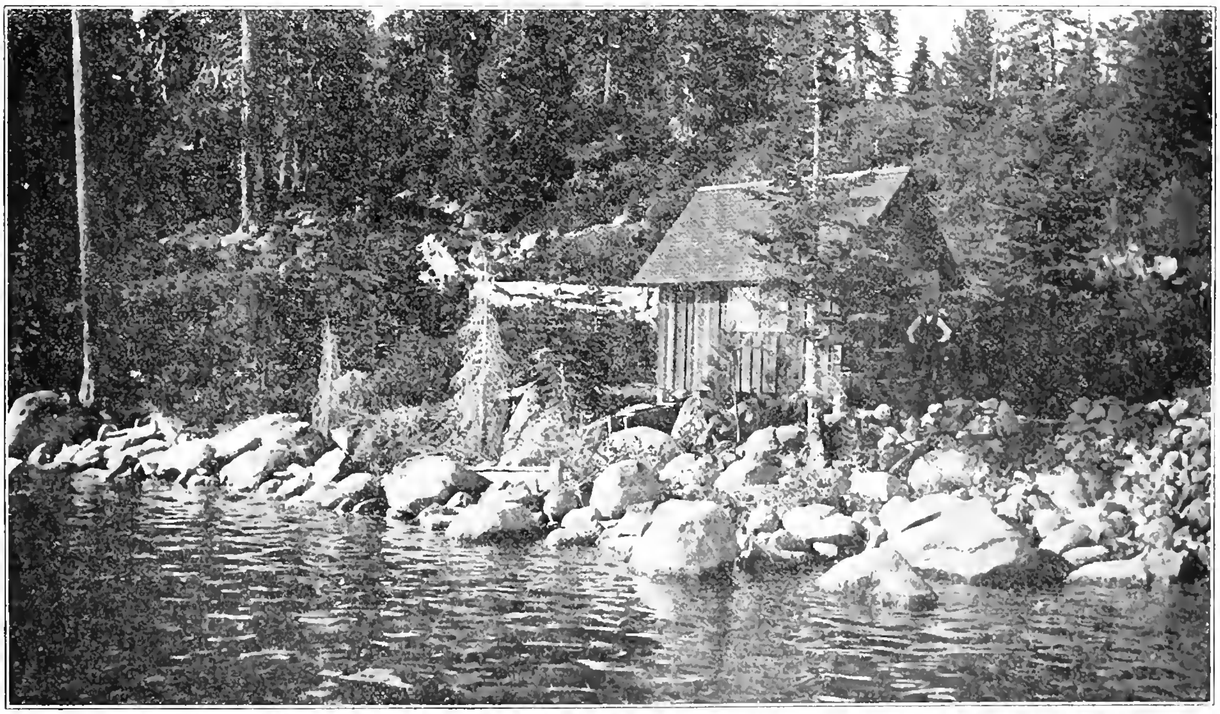
A MODEL HYDRO-ELECTRIC INSTALLATION

In these days of conservation, we are all interested to know just what can be done with our natural resources. A very unique example of utilizing a small stream of water for the convenience, comfort and economy of its owner is a plant herein described. This installation was purchased and installed by Mr. Harry Babcock on his beautiful country home on the shores of Lake Tahoe, near Tallac, California. The little mountain stream which flows across Mr. Babcock's property has been idling itself away for countless generations, its only usefulness being that of adding its rythmic accompaniment to the already beautiful mountain symphony.



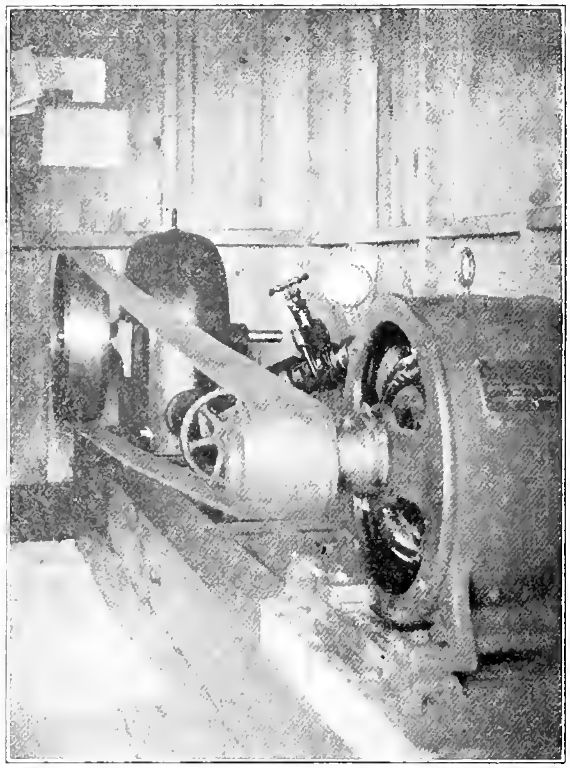
Model Hydroelectric Plant on Shore of Lake Tahoe.

Without in the least detracting from all that nature has done for this ideal summer home, Mr. Babcock has, by harnessing a small percentage of the water flow, placed himself in possession of all the conveniences and comforts of a city home. The accompanying photographs show how he has concealed the pipe line down the mountain side to the small power-house. The reservoir back in the canyon stands at a level of approximately 130 feet above the water-wheel, and he thus has ample pressure to carry the heaviest loads he can place upon the generator.

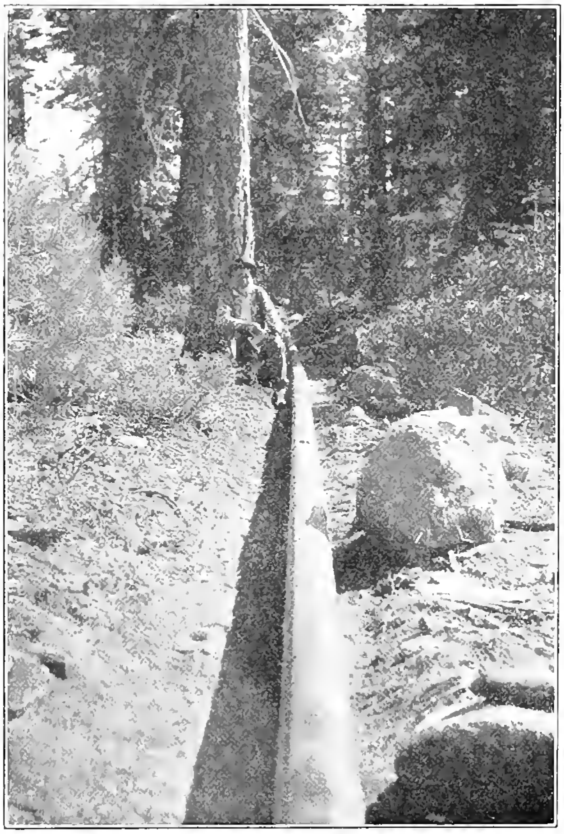
The power-house itself is complete in every detail, consisting of a Pelton impulse water-wheel, which is belted to a 4 k. w., 1350 r. p. m., constant speed, Westinghouse direct current generator.

The hydraulic conditions under which this small plant operates involve a total head of 124 feet and a pipe line consisting of approximately 723 feet of 6-inch and 722 feet of 5-inch pipe. This, together with

the water motor, was furnished by the Pelton Water-Wheel Company. The pipe line is the ordinary double riveted, sheet steel piping, dipped inside and out in asphaltum composition and provided with slip-joints. In laying the pipe great care was exercised in driving the joints so that the rivets were not started. To assist in making a perfect joint a gasoline torch was employed for heating the large ends of the slip-joint sections. On cooling, the pipe naturally contracted, after which it was painted with an asphaltum preparation, and a perfect joint resulted. Such care was exercised that notwithstanding the great length of the pipe line, practically no leakage resulted, merely the ordinary sweating observed on all such lines.



Generator.

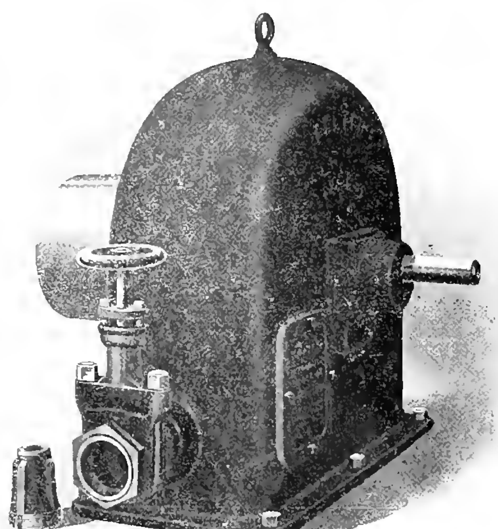


Pipe Line.

In addition to conveying water for the use of the wheel in the power-house, a branch pipe serves the dwelling, besides affording fire protection by means of hydrants located at advantageous positions. The power-house, being located at some distance from the dwelling, wherein is located the switchboard, the main stop gate valve was placed in the pipe line at a point some 200 feet from the dwelling. The gate valve is operated by a system of levers and a wire cable terminating in a winding drum. By this means the wheel may be started or stopped and hand regulation obtained without the necessity of journeying to the power house for this purpose.

Belted to the electric generator is a Pelton 24-inch type "C" motor of similar design to the illustration herewith, but equipped with a regulating nozzle which is manually operated. As the entire number of lights installed do not burn continuously, the needle nozzle is set to carry the maximum night load. Then as the load gradually drops a solenoid device cutting in and out a resistance, maintains a constant load on the wheel, thus insuring uniform speed.

This regulator consists of a group of resistances, which are shunted across the main terminals of the generator, through solenoid switches. These solenoids are placed in series with the main load circuits, and are designed in such a way that if the load, or any part of it, is suddenly removed, the switches will close and shunt in an equivalent amount of resistance, so

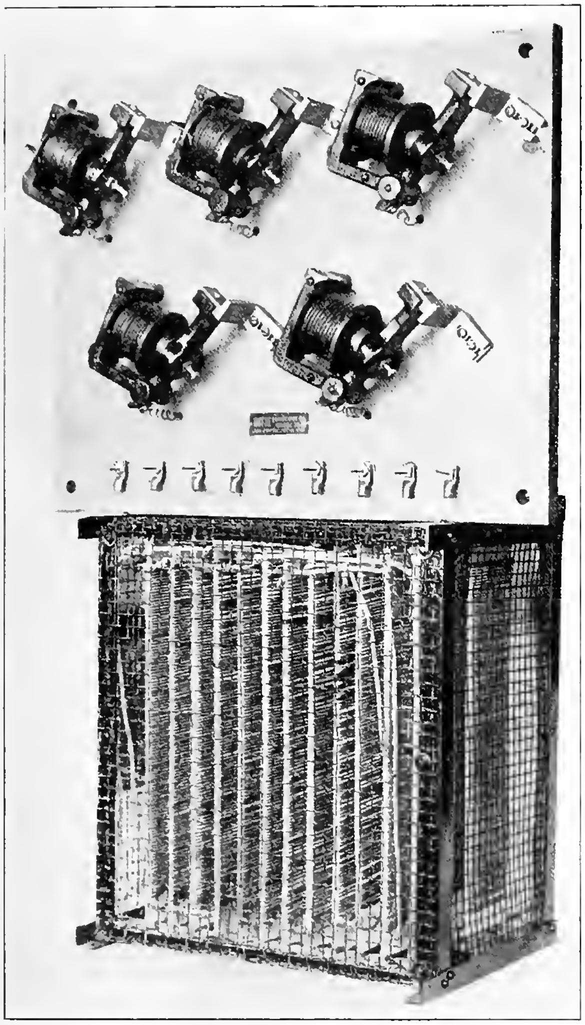


Pelton Water Wheel.

that an approximately constant load is kept upon the generator at all times.

The distribution circuits extend some 200 feet from the power-house to the residence and out on the wharf, over the edge of the lake, and along the various walks of Mr. Babcock's spacious grounds.

The generator is controlled by a standard panel, on which is mounted a voltmeter, an ammeter, a main switch, field rheostat, and pilot lamp, as well as distribution switches. Mr. Babcock has also installed a voltmeter in his residence, so that it is possible for



Regulator.

him to start up the plant from the hydraulic valve control, above mentioned, and bring the machinery up to the right speed without going near the power-house.

A small isolated power plant of the above description possesses many advantages over gasoline engines and other forms of prime movers, because of the simplicity of the water-wheel mechanism and the benefits derived from having a constant water pressure available at the dwelling for fire protection and the installation of fountains about the grounds of the dwelling. The cost of such a water-power installation is nominal, while the maintenance charges are practically negligible, no skilled attendance of any sort being necessary.

SCIENTIFIC BUSINESS METHODS.[1]

BY HARRY N. TOLLES.

We are all of us in business for a purpose and the topic of economy is one that I believe is a paramount question that every man is interested in, so far as his own energies are concerned. I want to talk to you on the question of economy. There are fellows in the business world who revolve round and round the same thing and never seem to get anywhere. The other fellow comes in and is promoted. I know an industry in this city, one of the biggest of its kind in the country. I went in there one day to confer with a man, and I found that his superintendent was, about six or eight years ago, acting as his office boy, and he had been standing still on exactly the same plane all that time.

Now, success and advancement depend upon natural law. There is such a thing in the success problem as the law of truth and principle, which, if followed, can help to make a man successful. I want to first take up the question of determining the value of yourself or anyone in your employ. What is it that determines the value of a man? The value of the individual is equal to that individual, minus the supervision he requires in his work. The less looking after that employe requires, the more valuable he is to you. Take stenographers, for example. I dictate a letter. One girl makes a few chicken tracks across the page, and writes the letter. It comes to me misspelled, not properly punctuated, paragraphed, and so forth, and I have to make corrections and I have to send it back. She is only a would-be stenographer. Number Two comes to me; I dictate the letter and she writes every word down and does the work properly. She is more valuable than Number One, because she requires less supervision. Number Three comes and I sort my mail and say, "Tell this man we can't do that, or tell this man we had this matter up and we decided this in connection with it." And she will compose that letter. Once in a while there will be a letter I have to compose to her in detail, but she will get that dictation properly. Here comes Number Four. My mail, instead of coming to my desk, goes to her; she opens the mail and she runs through and sees there are certain things she can attend to as well as I can, and she brings me that mail ready for my signature. What is the difference in these four different stenographers? Simply the amount of supervision they require in their work.

Supervision is made necessary in our work because of two little things: errors of omission plus errors of commission. You take the mistakes that you make or your employe makes, things omitted that should be done, things that are done that never should have been done, and you subtract them from the entire work of that individual and you will determine the value of the individual. But if you can go a step further and find out where those mistakes come from and stop the leaks, then you have made progress.

All through life, there is a duality of forces at work. There is the positive and the negative. Light is positive and darkness is its negative; heat is positive and cold is its negative; and so in the mind and in

[1]Address delivered before Technical Conference, International Independent Telephone Association, Dec. 7, 1909.

the body. We have health, positive, and sickness, its negative; strength, a positive, and weakness, its negative. The thinking part of the mind is divided into three parts: the thinking, the feeling and the willing part. In the thinking, we have first, observation. Every idea that ever came into your head or mine came through one of the five physical senses. If it came from without, either we heard it or we saw it, we smelt it, we touched it, or we tasted it. Therefore, it is extremely important that we should train ourselves to be good observers through these five physical senses. Then comes concentration; then comes memory, and judgment is next.

Imagination is the great image-making power of the mind, and there is where man's progress has been made in the last half century, or possibly the last quarter of a century; where the most progress has been made in the telephone business. No invention was ever made by any of you, in your business, until you had the image in your mind. One course of study the business man should pursue is the study of constructive imagination. A premium is put on the man today that trains the imagination and imagines accurately and has the judgment and reason to back it up.

The next function of the mind is the feeling side. One says, "What has feeling to do with business?" I say it has a great deal. Here we have faith, with its doubt; courage, with its fear; loyalty, with its disloyalty; honesty, with its dishonesty. And you can go on with a legion of these. At any rate, there are a great many feeling elements of the mind which must be trained and developed.

Did you ever see an employe make a success of his business, if he doubted he could do it? Was not your company formed because somebody believed in his ability to form it, and then went to work and talked up his belief to get other people to believe in him and in his proposition? Faith is a great asset in the business world. Loyalty is a starting point in the selection of employes. The very first question you should determine in the hiring of an employe is, "Will he be loyal?" If he left the position he has left to come to you because he was disloyal, then look out for him. I believe disloyalty is the first step towards dishonesty; that dishonesty is a step towards theft. How does it work? The fellow says, "Oh, thunder, I am only getting $18 a week and I know I am worth $20 or $25; what's the odds if I do knock off half a day? It's coming to me." Or if the boss is out and he is not supposed to use this telephone service and he uses it for a long distance call, worth fifty cents, he says, "I am entitled to it; it's coming to me." There are a hundred and one ways in which that person can steal a little and not call it stealing at all. It starts from disloyalty.

Now as to the next function of the mind, the will power. It has indecision as a negative, an inaction. Every mistake you and I make, or have ever made, can be traced to some one negative or combination of negatives in ourselves. Remember this. The success of your institution is no more than the sum total of the successes of the individuals in your institution. There can't be a failure from the wrong adding up of a single column of figures; there can't be a failure from the one salesman who goes out and misrepresents and falls down, but it subtracts just that much from the success of your institution. Every mistake is traceable to a negative or some combination of negatives. For instance, suppose it is weakness. That operator comes to the office. She has been out pretty late the night before and has a headache or an attack of indigestion and asks to be excused. It is just as much her business to preserve and keep that health, as to keep any other function of the body or the mind. Health is a harmonious condition of the three parts man has: the body, the mind and the soul. And there is such a thing as a diseased condition of the mind, as well as there is a diseased condition of the body. Suppose it is simply weakness and forgetfulness. The thing for us to do, if we want to increase the value here, is to eliminate that weakness and that forgetfulness and increase the strength and the memory. How can it be done? If this room is full of darkness, what do you do? You simply turn on the lights, of course. A muscle is weak. I exercise that muscle, systematically until it grows. If I don't feed it, it won't grow.

Therefore, there are two things necessary in the development of the faculties of the mind, and also of the physical man. One is proper food and the other is proper exercise. Has a single idea been put into your mind by anybody else since you arrived in the city of Chicago, which has not been proper food for your mind? I believe there is such a thing as poisoning the mind, just as you can poison the body. Anything you hear that does not help you, hinders you, and you cannot afford to alow matters to get into your minds that do not help you. Therefore, let us expose the mind to the best things, the best food.

Now, there are three ways to develop the memory. Remember three simple rules and you can make a gigantic power of that mind of yours. They are the rules for health and for strength. The present school system of today is built up on the principle of cramming the mind. I am not deploring the school system, but there is such a thing as getting so close to educational problems that you cannot see them. Go back to the old Latin meaning of the word education—educt, to draw out—and you can start tomorrow with every employe you have, to, in some way, get in touch with his mind. The thing we are after is the drawing out, the education of the forces of the individual. By doing that, we increase the positives and we decrease the negatives. By decreasing the negatives, we naturally stop the leaks, so to speak, and we decrease the mistakes that occur. This, in turn, decreases the amount of supervision and increases the amount of value. In other words, the value of that individual can be increased by the development of his positive forces.

Now, let us take another step. By the development of the positive body, we get endurance. I don't care where a man works in your concern. He needs to have the principle of endurance trained in him, and the better he can endure the better he can succeed.

In the training of the physical forces of a man, endurance can be prominently mentioned. The fellow who can get into the game and stay in the game is the man of endurance. And as you train the imagination and reason, you get the ability. Hence, you should train the feelings of faith and loyalty and courage and honesty and ambition. Reliability comes next in the

will power after decision and action. We have activity, and I submit to you that the man who has endurance, and the man who is a good thinker, and the man who is reliable, and the man who has action, is the man to go out and be successful, no matter where you put him.

Every person, if he is a normal man, has fifty-two positives. Roosevelt started out lacking health, and he went out on the plains and developed himself into a man of mighty action and strength. Sandow, they tell us, was born a helpless invalid, and yet he became a great giant. The same thing is true of every one of those muscles. I don't mean by that you can achieve an impossibility, but I say it is possible to raise each person just a little, and by the raising of that person just a little you are going to make him a better thinker, a better actor, because you cannot take a step, you cannot move a hand, or say a word, that the mind does not operate. Therefore, if a man would control his words, his acts, his deeds, the thing for him to do is to control his mind.

Salesmanship is the power of persuading people to purchase, at a profit, that which we have to sell. Did you ever analyze the power to persuade? Tennyson says: "Knowledge, reflection and control, these three alone lead to sovereign power."

In every sale there are four factors at work. First, the salesman; second, the customer; third, the thing sold; and last, the sale itself. If you want to develop the salesman, the thing to do is to develop his mental faculties. It is infinitely easier to train and develop a person if he is loyal and wants to get ahead. It is easier to correct the negatives in that person than it is to go out and hire somebody else.

There are various types of customers. You cannot handle them all alike, if you are selling them. While it is true there are no two men alike in this world, all men classify themselves naturally into certain different types and temperaments, and it is folly to attempt to handle one type as you would another. Even the inflection of the voice means something. If you want to influence a man you won't walk ten feet in front of him, or ten feet behind him. No, you will walk right beside him. You must learn to walk mentally with the person to whom you want to make the sale. What you say should fit like cogs in the mind of that customer.

The next thing is the thing sold. Logic is the thing that helps most. Logic is divided into two branches: first, the ability to analyze the proposition; and second, the ability to synthesize it or build it up. In your advertising, you do the same thing. You present your points to your customers, but you find you have a lot of them and those points have to be so small you need to be an expert on the points of your proposition. Then after you get them all laid out, synthesis comes in and you synthesize or arrange those points in logical order. So many fellows go out to sell goods who have just a hazy idea in their minds of what they have to offer.

The last is the sale itself. The branch of science that helps most there is the branch of psychology. Here come attention, interest, desire, and resolve to buy. Every mind comes to each of those four stages every time.

First, attention. If that glass of water is full, you cannot get any more water in it without spilling out some of that. And if you want to get that customer, the thing for you to do is to spill that mind first before you can get your ideas in it. Next, interest; then desire. Interest is only a little more than attention; desire comes from the logical arrangement of your selling points. It is points that sell goods today. The time of the human cyclone, the wind-mill and the talking machine is over. Points sell goods. Then you have got to get resolution. Attention, interest, desire, and resolve to buy. And all through the whole transaction there has got to be a feeling of confidence.

After the sale is made the law of mutual benefit has to operate. No sale is a good sale unless it is clearly advantageous to both buyer and seller and, therefore, satisfaction must result. Satisfaction makes that customer a repeater, and a link in an endless chain to bring more customers to your business.

NITRATES IN NORWAY.

Supplementing previous articles on the manufacture of air nitrates for fertilizer in Norway, Germany and Niagara Falls, Canada, it is learned from British consular reports that the industry is undergoing rapid expansion in the first-named country, where nearly $15,000,000 will be invested. Though there are vast water powers in the United States running to waste, which could be utilized to produce this article, nothing has yet been done in that line, although this country is buying annually about $15,000,000 worth of Chilean nitrates.

About $6,000,000 has been expended on the works at Notodden and Svaelgfos and the power stations under construction at Rjukan and Vamma. When all the works are completed, at the end of 1910, $14,600,000 will have been spent. A great point in connection with the development of this industry, is that the opportunity has now arisen of opening up several industries in connection with the manufacture of nitrates, such as nitric acid, nitrate of ammonia, nitrate of potash, also sodium nitrate, which last is already being manufactured.

The Nobel syndicate, in conjunction with the Birkeland and Eyde Company, is now concentrating the weak acids, with the assistance of the gas furnaces, to an acid of such percentage as to become an article of transport, and further opportunities have thus been opened for export trade, especially from works with water power that are situated near the seaboard.

It is of interest to note that no coal is used in the production of saltpeter or other products here referred to. It is stated authoritatively that there is no probability for many years to come that the sale of saltpeter produced by the method practiced at the Notodden and Rjukanfos works will be disturbed by competition with Chile saltpeter on the question of price.

When the Rjukan Falls works are fully completed, they and the Notodden works combined will represent 240,000 horsepower, with a production of saltpeter representing an export value of $6,164,000.

The value of the output of nitrates in Norway in 1908 was about $536,000, and the total expenses amounted to $402,000.

AN ALTERNATING CURRENT CALCULATING DEVICE.

BY F. G. BAUM.

Usually one of the most important questions concerning a system of electrical transmission, transformer, or generator, or any combination of these, is regulation. That is, for a given receiver pressure, by what percentage must the delivered or generated pressure exceed the receiver pressure, not only for unity power-factor but for loads of any power-factor. A simple device will be herein described which will give the regulation of any system *for any load and any power-factor* without making a diagram for each case. To use the device it is only necessary to determine two constants, which are usually given or are easy to determine. To make the explanation simple, let us confine ourselves to a transmission line. We are to determine the regulation for any load and any power-factor; that is, the percentage by which the pressure delivered to the line by the generator must exceed the receiver pressure for *constant receiver pressure.*

Taking the lost pressure as a whole, we are always concerned with three pressures in any case: (1) the receiver pressure, (2) the lost pressure over the line, (3) the pressure delivered to the line. (This is also true for generator or transformer, or any combination of transformer, generator, and line.) The lost pressure is made up, in any practical case, of the resistance pressure and the reactance pressure. When, as is generally the case, we have receiver loads of different power-factors, we get

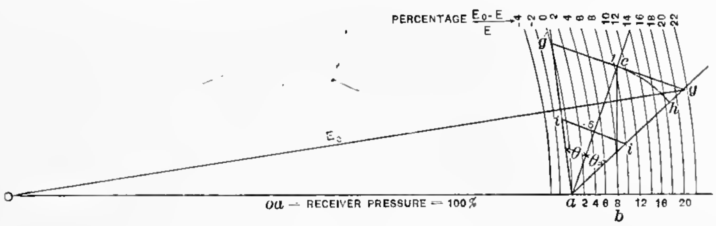


Fig. 1. Regulation of Transmission System.

simpler results if we consider the total receiver current divided into two parts, one the *power component* and the other the *wattless component* of the receiver current, and regard each as flowing separately over the line. If I is the total receiver current and θ the angle of lag of the receiver current behind the receiver pressure, the power component of the receiver current is $I \cos \theta$, and the wattless component is $I \sin \theta$. (Cos θ is the power factor of the receiver circuit; for a non-inductive load $\cos \theta = I$, and $\sin \theta = 0$.) Let $E = oa$, Fig. 1, represent the receiver pressure. The pressure consumed by the line resistance and reactance due to the power component of the load current is $I \cos \theta \sqrt{R^2 + (Lw)^2}$, in which R is the resistance and Lw is the inductance or reactance of the line. In Fig. 1,

$$ab = I \cos \theta \, R$$

$$bc = I \cos \theta \, Lw$$

Therefore $ac = I \cos \theta \sqrt{R^2 + (Lw)^2}$.

ab is 8% of the receiver pressure; that is, the I^2R loss in line is 8% at full non-inductive load.

ac represents, then, in magnitude and direction, the pressure consumed over the line by the power component of the receiver current. If for a lagging current we make the angle $cag = \theta$ (θ is the angle by which the receiver current lags behind the receiver pressure), and the angle $acg = 90^\circ$, then

$$cg = I \sin \theta \sqrt{R^2 + (Lw)^2},$$

as can be proved by simple geometry. That is, cg represents in magnitude and direction the pressure consumed over the line by the wattless component of the receiver current. (If the receiver current leads the receiver pressure by the angle θ, then cg' is equal to the pressure consumed by the wattless component of the receiver current.) It should be particularly noticed that the pressure consumed by the wattless current is at right angles to that consumed by the energy current. Notice also that ac is proportional to the power current, and cg to the wattless current. The true direction of the power current is along E, and the wattless current at right angles to E,—downward for lagging, upward for leading current. The line ag therefore represents in magnitude and direction the pressure consumed over the line by the total receiver current. Hence og represents E_0, the pressure delivered to the line, in magnitude and direction.

ac represents the pressure consumed by *full-load* non-inductive current. Then $ac/2$ will represent half load on line, etc. For half load, and the same angle as before, E_0 is given by oi. Through c, with a as center, a circular arc has been drawn. At *full-load current*, and a power-factor corresponding to the angle θ, the value of E_0 is given by oh.

With o as center, circular arcs have been drawn through a, 2, 4, etc. The radial distance between two successive arcs is 2% of the receiver pressure. We see, as shown by the point c, that the regulation of this system for full non-inductive load is 11%; that is, the generator pressure must be 11% higher than the receiver; at *full kilowatt load,* at a power-factor corresponding to the angle θ, the regulation is 21%, as shown by the point g; *at full kilovolt-ampere* load, that is, for the same current as before delivered at the same power-factor, the regulation is 19%, as shown by the point h.

In Fig. 2 is shown a case for a receiver pressure equal to 10,000 volts (the point o is not shown). ac, which represents full load, has been divided into ten equal parts, corresponding to 0·1, 0·2, etc., lines have been drawn at right angles to ac. Radial lines making angles corresponding to $\cos \theta = 0{\cdot}95$, $\cos \theta = 0{\cdot}9$, etc., for lagging and leading currents, have been drawn from a. Circular arcs, with the point a as center, have also been drawn through points along ac marked 0·1, 0·2, etc.

The regulation for any load and any power-factor may be determined from the figure. For example, find the regulation at 0·9 *full load* at 0·8 power factor: Go along ac to $c^1 = 0{\cdot}9$, then along c^1g^1 to the intersection with the line $\cos \theta = 0{\cdot}8$. The regulation is seen to be about 21½%. For 0·9 full-load current,

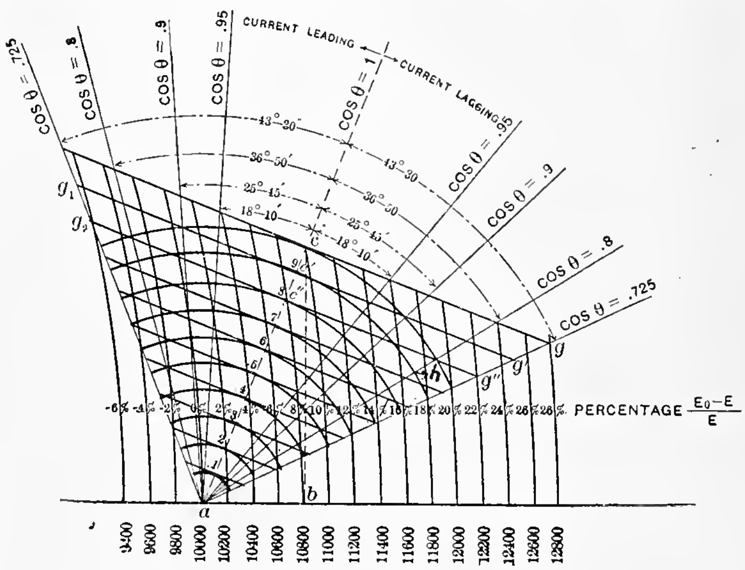


Fig. 2. Regulation of Transmission System.

and the same power-factor, the regulation is 17%. as shown by the point h.

It is seen that for any given case it is only necessary to

determine the triangle *abc*; the remainder of the figure is drawn mechanically. The labor of making the drawing for each case may be eliminated if, instead of laying off *oa* to represent a particular receiver pressure, we let it represent any receiver pressure and call this pressure 100%, Fig. 3*a*.

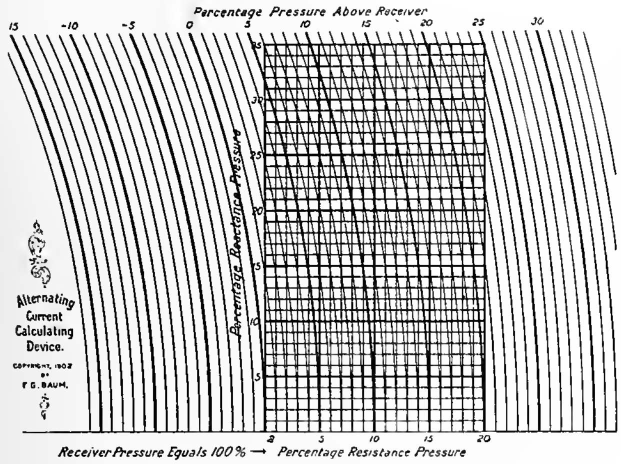


Fig. 3a. (*Half size.*) *Printed on cardboard.*

Now all that is necessary is to determine the resistance and reactance pressure in *percentage* of normal receiver pressure for any particular case, and lay them off horizontally and vertically

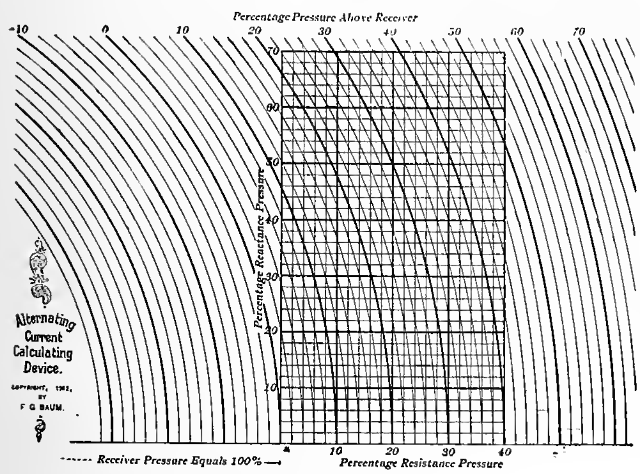


Fig. 3b. (*Half size.*) *Printed on cardboard.*

to obtain the triangle *abc*. For convenience, Figs. 3*a* and 3*b* are made to cover all cases met with in practice. Points along the horizontal represent different values of *ab*, the resistance pressure in percentage of delivered pressure; and points along the vertical, different values of the percentage pressure consumed by reactance. Circular arcs with *o* as center (the point *o* is not shown) have been drawn in Fig. 3*a*. We see that the other lines in Fig. 2, now shown in Fig. 4, always bear the same relation to each other, and in the calculating device these are, therefore, printed on a sheet of transparent celluloid. By placing Fig. 4 on Fig. 3*a* or 3*b*, and fastening at the circles at *a*, so that one may be rotated with respect to the other, we get a device that applies to any case. The distances 0 to 1, 1 to 2, etc., on Fig. 4, are the same as the distances 0 to 1, 1 to 2, etc., on Fig. 3*a*. When the reactance pressure is greater than 35% use Fig. 3*b*.

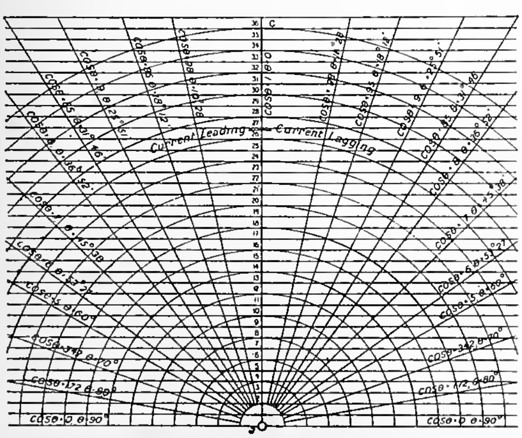


Fig. 4. (*Half size.*) *Printed on transparent celluloid.*

Fig. 5 gives an example of the application to the calculation of the regulation of a line. Here the resistance pressure, or copper loss, equals 7% at full non-inductive load; reactance pressure equals 20% at full non-inductive load.

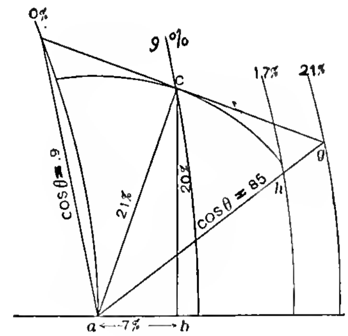


Fig. 5.

ac is rotated until it passes through the intersection of 7% and 20%. The number 21 coincides with 20 and 7, therefore the pressure consumed over the line at full non-inductive load is 21%. (When using Fig. 3*b*, numbers along *ac*, Fig. 4, are to be multiplied by 2.) 21 represents full load on line, 10½ will represent half load, etc. The regulation at non-inductive full load is seen to be 9%. For *full kilowatt load* at 0·85 power-factor move along 21 to *g*; regulation equals 21½%. For *full kilovolt-ampere load* at 0·85 power-factor move along 21 to *h*: regulation equals 17%. For equal generator and receiver pressure at full load move along 21 to arc marked 0%. The figure shows that for 0·9 power-factor, for leading current, the receiver pressure would be practically equal to the generator pressure for all loads; that is, the line would be self-regulating.

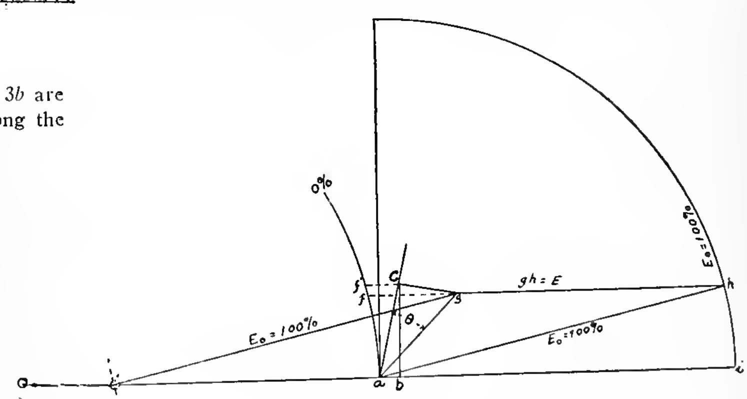


Fig. 6. Determining Drop in Pressure.

Circle *ih* is drawn with *o* as center.
Since $oa = E_0$, $fh = E_0$, $o'a = gh = E$; ∴ $ao' = fg$.

The device may be used to find the receiver pressure when the generator voltage is kept constant. In this problem the generator pressure would be called 100%. Now, for a given current drawn by the receiver at a given power-factor the voltage over

the transmission line represented by ag, Figs. 1 to 6, remains constant; that is, the point g is a fixed point for the power-factor $\cos\theta$. If E_0 is 100%, to get the receiver pressure, E, we describe a circular arc with g as center to cut oa in o', Fig. 6. The length $o'a$ is then E, and the length oo' is the percentage drop in pressure over the line. But it is easily seen from Fig. 6 that $oo' = fg$, and therefore the percentage drop in pressure over the line when E_0 is fixed at 100% is the *horizontal* distance from g to the circular arc marked 0%, drawn with o as center and radius $oa = E_0 = 100\%$. For the same current drawn by the receiver at unity power-factor the length cf' gives the percentage drop in pressure. If the point g falls to the left of the 0% arc the horizontal distance to the circular arc represents the rise in pressure.

In Fig. 3*a*, ⅛″ represents 1%; and in Fig. 3*b*, 1/16″ = 1%. The length from g to the 0% arc may, therefore, be read off with an ordinary rule. It should be remembered that this distance is to be measured parallel to the base line. The percentage decrease in load, due to a decrease in E below 100%, will also be given by the length from g to the circular arc 0%. For, lengths along ac are proportional to energy current, but since the pressure on the receiver is not 100%, ac will not represent the same receiver load, but the load will be changed as E changes. If $gh = E$, and $gf = E_0 - E$ is, say, 25%, and ac represents full-load energy current, then the receiver load will be 75% of full load. That is, the length gf represents the percentage decrease of load. If the load is non-inductive, for the same energy current, ac the decrease in load will be given by cf'.

The device may also be used to solve the problem of finding the percentage reactance pressure when the regulation is given, or to solve any right-angled triangle when two sides are given in percentage.

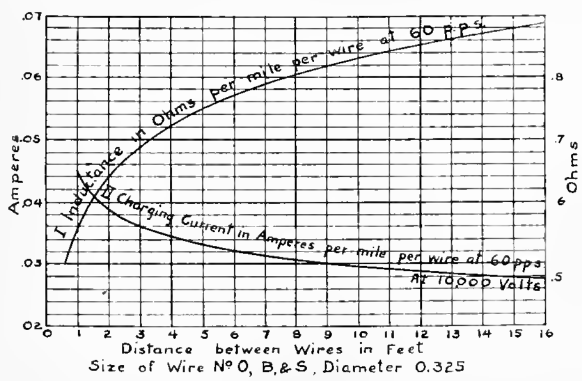


Fig. 7. Reactance and Charging Current per Mile.

Curve I. Inductance per mile, per wire at 60 p.p.s. For single-phase or two-phase, multiply by 1·15.

Curve II.—Charging currents per mile per wire for three-phase system at 60 p.p.s., 10,000 volts between wires. For single-phase or two-phase, multiply by 0·87.

For wire ¾″ in diameter, spaced 12 feet, the charging current is 0·0331 amperes per mile with 10,000 volts between wires. This is 4% less than for No. 0 wire spaced 48″.

When considering the regulation of a generator or transformer we have to deal, as in the transmission line, with a delivered, or secondary pressure; a resistance and reactance pressure consumed in the generator, or transformer; and the pressure generated, or delivered to the transformer. Therefore, in determining the regulation of a generator or transformer we proceed as in the case of a transmission line.

On the back of the device are given the values of the current and (current)^2 for the different power-factors, assuming the current at unity power-factor to be 1. Other useful information is also given.

Manufacturers of electrical apparatus now, very properly, specify the regulating properties of a transformer, or generator, by giving the resistance pressure and reactance pressures in percentage of delivered pressure, so that the calculating device is in its most convenient form. The percentage resistance pressure is, of course, equal to the percentage copper loss in a generator, transformer, or line at non-inductive full load.

We see from what has been said that in order to use the calculating device to determine the results desired it is necessary to determine the resistance and reactance pressures consumed by full-load current, the pressures being given in percentage of normal voltage at the point of fixed pressure. Methods of determining these pressures will now be given.

Calculation of Percentage Resistance and Reactance Pressures of Transmission Lines.

Let R = resistance of one wire from generator to receiver in ohms; Lw = reactance of one wire from generator to receiver in ohms. (For Lw take inductance per mile from the curve in Fig. 7 and multiply by the length of the line in miles.) Let also, I = amperes per wire at non-inductive full load; E = e. m. f. between wires in volts at point of fixed pressure. Then, for three-phase, percentage resistance pressure $= \sqrt{3}(IR/E)100$; percentage reactance pressure $= \sqrt{3}(LwI/E)100$.

For single-phase or two-phase system replace $\sqrt{3}$ in the above by 2.

Example.—Length of line = 15 miles, voltage between wires = 5000, and full-load current = 60 amperes. From the curve in Fig. 7 we find the inductance = 10 ohms for 30″ between wires.

$$\text{Hence, percentage reactance pressure} = \frac{\sqrt{3}\times10\times60\times100}{5000} = 20{\cdot}75.$$

For a line 150 miles long, and 50,000 volts between wires, the percentage reactance pressure is practically the same.

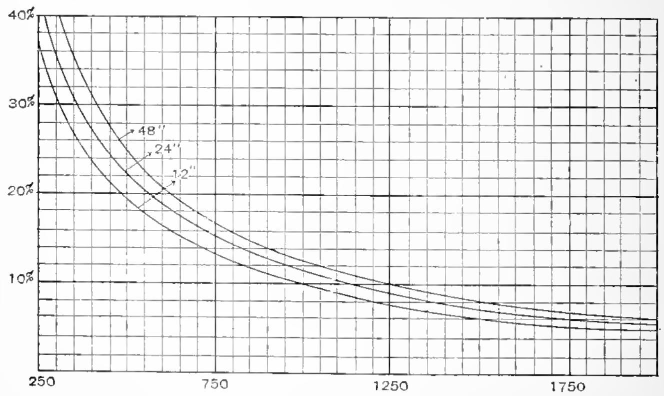


Fig. 8. Ratio of $\dfrac{\text{Volts Between Wires}}{\text{Miles of Line}}$.

Curves give percentage reactance at 60 p.p.s.

Conditions: Three-phase system, No. 0. B. & S. wire, 100 amperes per wire.

For single-phase or two-phase, multiply ordinates by			1·15.
For any other current	"	"	$I/100$
For any other frequency	"	"	$f/60$
For No. 1 wire,	"	"	1·02.
For No. 2 wire,	"	"	1·04.
For No. 3 wire,	"	"	1·06, etc

For wire ¾″ in diameter with 12 feet between wires add 4% to curve for No. 0 wire spaced 48″.

We see that in the formula for the reactance pressure we always have the ratio of the voltage between wires and length of line in miles. Assuming a given number of amperes flowing in the line, say 100, we may construct a curve between the percentage reactance pressure and the ratio of volts to length of line in miles $= E/L$. This has been done in Fig. 8, from which the percentage reactance pressure for any given case may be quickly determined. Curves are given for 12″, 24″, and 48″ between wires. The results are given for a three-phase line with 100 amperes per wire, frequency = 60 p. p. s., size of wire equals

No. 0, B. & S. These curves bring out in a striking way the effect of reactance in the line, and the difficulties of regulation in long lines. For any other current, I, multiply the percentage reactance pressure by $I/100$; for any other frequency multiply by $f/60$. For a single-phase, or two-phase system, multiply the percentage reactance pressure by 1·15. For No. 1 wire multiply the percentage reactance pressure by 1·02; for No. 2 wire, multiply by 1·04, etc. A great deal of labor may be saved by becoming familiar with the use of Fig. 8.

Example.—Voltage between wires = 50,000; distance between wires = 24"; length of line = 100 miles. Then $E/L = \frac{50,000}{100}$ and from the curve, Fig. 8, we find the percentage reactance pressure = 22·1. The reactance pressure in volts per loop will be $\cdot 221 \times 50,000 = 11,050$, or $\frac{11,050}{\sqrt{3}} (= 6390)$ volts per wire.

Measurement of Percentage Resistance and Reactance Pressures of Transmission Lines.

Measure R as usual and calculate the percentage resistance pressure; then short circuit receiver and determine the percentage of normal receiver pressure necessary to force full-load current over the line. Suppose, as in Fig. 5, the percentage resistance pressure = 7%, and that 21% of normal receiver pressure is necessary to force full-load current over the line when on short circuit: ac is rotated until 21 and 7 coincide, and the reactance pressure = 20%, is read off.

Determination of Percentage Resistance and Reactance Pressures of Transformers.

The resistance pressure, or copper loss, of small lighting transformers is about 1½ to 3%. For large transformers the resistance pressure may be 1% or less. The percentage reactance pressure of transformers is usually between 3 and 10%—about 3 to 5% for 2000 volt, medium-sized transformers.

If copper loss and regulation on non-inductive load are given, then the percentage reactance pressure may be determined from Fig. 3.

Example.—Resistance pressure equals 1½%, and regulation on non-inductive load given as 2%: Follow the circular arc marked 2% from the bottom of the figure until it passes through the horizontal line marked 1½%. The length of the vertical line, 9%, gives the reactance pressure.

In using the calculating device to find the regulation of a transformer, the pressure delivered by the transformer is the receiver pressure. ab and bc, then, being determined in percentage of the delivered pressure, we obtain the percentage by which the primary pressure, divided by the ratio of transformation, must exceed the secondary pressure. In determining the regulation of a transformer proceed as in the case of a transmission line.

Example.—Resistance pressure equals 1½% and reactance pressure 9%. Regulation on non-inductive load equals 2%; regulation on 0·9 power-factor, lagging current, equals 6%.

If the primary pressure is fixed, the percentage drop in pressure through the transformer is measured by the horizontal distance, g to the 0% arc, as in Fig. 6.

Resistance and Reactance Pressure of Transformers by Measurement.

Let R = resistance of primary, r = resistance of secondary, a = ratio of transformation, I = primary current, E = primary pressure. Then percentage resistance pressure $= \frac{I(R + r a^2)\,100}{E}$

To find percentage reactance pressure: Short circuit secondary and determine percentage of normal pressure which applied to primary will send full-load current through the transformer. The percentage resistance pressure is the base, and the percentage pressure to give full-load current on short circuit is the hypotenuse of the triangle abc. Rotate ac until a triangle is obtained having the requisite base and hypotenuse, then read off the reactance pressure in percentage.

Percentage Resistance and Reactance Pressure of Generators.

If a generator has 2% resistance pressure, and the regulation on non-inductive load is 6%, what is the reactance pressure? The circular arc, Fig. 3, marked 6%, passes through the horizontal line marked 2% and the vertical line marked 28½%. Therefore the percentage reactance pressure is 28½%.

Reactance Pressure of Generator Determined by Measurement.

Measure resistance as usual, and calculate the percentage resistance pressure by the formula $IR100/E$. To measure the reactance, or the synchronous reactance, as it is generally called: Short circuit generator, run at normal speed, and determine the pressure generated (this is determined from the excitation) to force full-load current through the generator. Having two sides of the triangle, rotate ac until conditions are fulfilled, and read off the reactance pressure.

Another method of determining the synchronous impedance* is as follows: Run the generator as a synchronous motor at no load. Now lower the excitation of the motor, or raise the voltage applied to it, until full-load current flows in the motor. Since the load on the motor is small, the pressure developed by it will be practically in opposition to the pressure applied. The difference between the pressure applied and the pressure developed by the motor (the pressure developed by the motor may be determined from the excitation) is the pressure, E', forcing full-load current through the motor. The ratio of E' to the normal pressure gives the percentage impedance pressure. The synchronous impedance is then

$$\text{Synchronous impedance} = \frac{E'}{I}.$$

$$\text{Percentage impedance pressure} = \frac{E'}{E}\,100.$$

In the last equation, E is the normal pressure delivered by the machine at its terminals. On account of the small resistance compared to the reactance, the impedance pressure may be taken as the reactance pressure.

Usually the synchronous reactance pressure varies between 25 and 50% of the normal pressure developed by the machine; for most generators it is between 30 and 50% of normal pressure. This means that the short-circuit current at normal voltage is between two and three times full-load current.

When we are considering the regulation of a generator, the receiver pressure is the terminal pressure. The value obtained for the "percentage pressure above receiver" is the percentage by which the generated pressure, E_0, must exceed the terminal pressure for the given load. If E is the terminal pressure, and the regulation is found to be 10% for a given load, the generated pressure must be equal to $1 \cdot 1E$. In any case, after determining ab and bc in percentage of the receiver pressure, E, we proceed as in the example given on the back of the calculating device.

If the generated pressure is 100%, the percentage drop in pressure through the generator is measured by the horizontal distance g to the 0% arc, as in Fig. 6.

Regulation of Transmission System.

If we wish to determine the regulation of a system consisting of step-down transformers, transmission line, and step-up transformers, we first find the percentage resistance and reactance pressure of each set of transformers and the line. Then add the percentage resistance pressures, and also the percentage reactance pressures, and treat as though this resistance and reactance were all in the line. If the generator is to be included add the resistance and reactance pressure of generator.

*The synchronous impedance is the apparent impedance.

Rise in Potential Over Transmission Line Due to Charging Current.

Suppose the percentage resistance pressure on full-load current to be 7%, and the reactance pressure 20%, as in Fig. 5; let the charging current be 50% of full-load current. (If the full-load current is 60 amperes, and the voltage between wires is 60,000, then at 60 p. p. s. the charging current of a line 150 miles long will be about 31 amperes.) This current may be assumed concentrated at the center of the line, and is practically wattless. Come down *ac* to $21/4 = 5{\cdot}25$, because we have half-load current taken off at the center of the line. Now go along a circular arc with center at *a*, the distance 5·25 from *a*, until we come to $\cos\ \theta = 0$, leading current. The rise in pressure is seen to be about 5%.

The percentage rise in voltage over a transmission line, due to charging current, may be rapidly calculated, with the help of the curves given in Fig. 7, by the formula:

$$\text{Percentage rise in voltage} = \frac{\sqrt{3} \times Lw \times \text{charging current} \times 100}{2 \times \text{voltage between wires}}$$

$$= \frac{\sqrt{3}\,(Lw \text{ per M})\,(\text{charg. current per M})\,(\text{length of line in M})^2 \times 100}{2 \times \text{voltage between wires}}$$

M = mile of line.

(This formula is approximate, but is accurate enough for all practical purposes.)

For single-phase or two-phase, replace $\sqrt{3}$ in the above by 2.

In Fig. 7 is given a curve for the charging current in amperes per mile at 60 p. p. s., with 10,000 volts between wires, for a three-phase system. For single-phase or two-phase multiply charging current by 0·87.

Application to Synchronous Motor Calculations.

Electrical engineers will immediately see the advantage of the device in adjusting the excitation of synchronous motors so that any degree of compounding of a transmission line may be obtained. This may be explained with reference to Fig. 2. *ab* represents the percentage resistance pressure, and *bc* the percentage reactance pressure consumed over the line between generator and motor when the motor is carrying *full load*, the power-factor at the motor terminals being unity. (We are to remember that the power component of current, at any power-factor, is proportional to *ac*, and the wattless component proportional to *cg*.) Suppose it is desired to excite the motor so that the pressure at its terminals shall remain constant for all loads, and that at 0·65 load the motor shall draw non-inductive current. The circular arc marked 6% passes through the point 0·65 along *ac*. The generator pressure, then, is to be 6% higher than the receiver at all loads. At any other load the motor must be so excited that the pressure consumed over the line by the wattless current will reach from the line *ac* to the 6% arc. That is, the locus of the point *g* must be along the 6% arc. At 0·2 load, for example, we see, by going at right angles to *ac* until we come to the 6% arc, that the power-factor must be 0·725, lagging current. The wattless component of current may be scaled off; for 0·2 load it is about equal to the load component. At full load we get the power-factor by going at right angles to *ac* at the point *c* until we come to the 6% arc. The power-factor is about 0·98, the wattless component being about 0·2, leading current.

The constantly recurring questions concerning the synchronous motor which come up when we operate such motors, especially on transmission lines, make it desirable to have some simpler method of making synchronous motor calculations than those commonly used. With the use of the calculating device, any problem concerning a synchronous motor may be solved without any mathematical work.

The theory of the synchronous motor is very much simplified if we look at it as the inverse of the generator. In the case of a generator, the important quantities are those measured at the terminals; that is, the terminal pressure, the current delivered, and the power-factor. We therefore take the delivered pressure applies. In the case of the synchronous motor, the important quantities are again the terminal values of the pressure, the current supplied to the motor, and the power-factor.

In the case of the generator, the diagram for determining the value of the pressure, E_0, to be generated for any load and any power-factor, is the same as Fig. 1.

Let us now operate this generator as a motor. E_0, the pressure generated, is now the back e. m. f. of the motor. Let x_0 be the synchronous reactance, and r_0 the resistance of the motor. E is the voltage applied to the motor (if E is not constant at the motor terminals, but at some point on the line, then the reactance and resistance of the line on the motor side of the point where E is maintained constant must be added to x_0 and r_0). If we leave E_0 drawn to the right as before we must reverse E and also the current, so that the motor consumes power. In Fig. 9 the ter- and the power component of the current as horizontal quantities. This gives us the simple diagram to which the calculating device

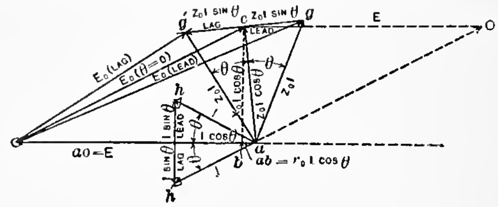


Fig. 9. Synchronous Motor Diagram.

minal pressure and current have been reversed. The terminal pressure is $ao = E$. I is the current delivered to the motor, and θ the angle between E and I. The pressure consumed by the resistance due to the power component of current is $I \cos\ \theta\ r_0 = ab$, and the pressure consumed by the synchronous reactance is $I \cos\ \theta\ x_0 = bc$. *ac* is, therefore, the pressure consumed by the impedance due to the power component of current. The pressure consumed by the wattless component will be at right angles to *ac*, to left of *ac* for lagging and to right for leading currents. (In the generator, lagging current consumes pressure to right of *ac* and leading current to left.) In Fig. 9, $z_0 = \sqrt{r_0^2 + x_0^2}$ is the synchronous impedance of the motor; and, therefore, $z_0 I \sin\ \theta = cg$, or cg', is the pressure consumed by the impedance of the motor by the wattless current. If the current for the load corresponding to *ac* is to be in phase with the terminal pressure, the motor must be excited so that the back electromotive force, E_0, is equal to *oc*. If the current taken by the motor for the same load is to lag by the angle θ, *og'* is the value of E_0; and if the current is to lead by the same angle, *og* is the value of E_0. *ac* is proportional to the power component of the current supplied to the motor—that is, proportional to the power input; and *cg*, or *cg'*, is proportional to the wattless component of the current. It will be immediately seen that the excitation to produce any given power-factor at any load may be at once determined.

The angle which *ac* makes with the vertical is determined, as in the case of the generator, by laying off *ab* and *bc*. Since *ab*, however, is laid off to the left of *a*, *ac* will be to the left of the vertical line instead of to the right, as in the case of the generator. The angle may be found on the right-hand side of the vertical, as in the case of the generator, and *ac* then rotated so as to make an equal angle to the left of vertical, or the angle may be laid off with a protractor. When solving synchronous motor problems, the words "lagging" and "leading" on the celluloid must be read interchanged. The angle between *ac* and *ab* will generally be between 85° and 90°, if E is constant at the motor terminals. If a transmission line is added between E and the motor, the angle between *ac* and *ab* will probably be reduced.

As there are questions arising sometimes, such as the over-

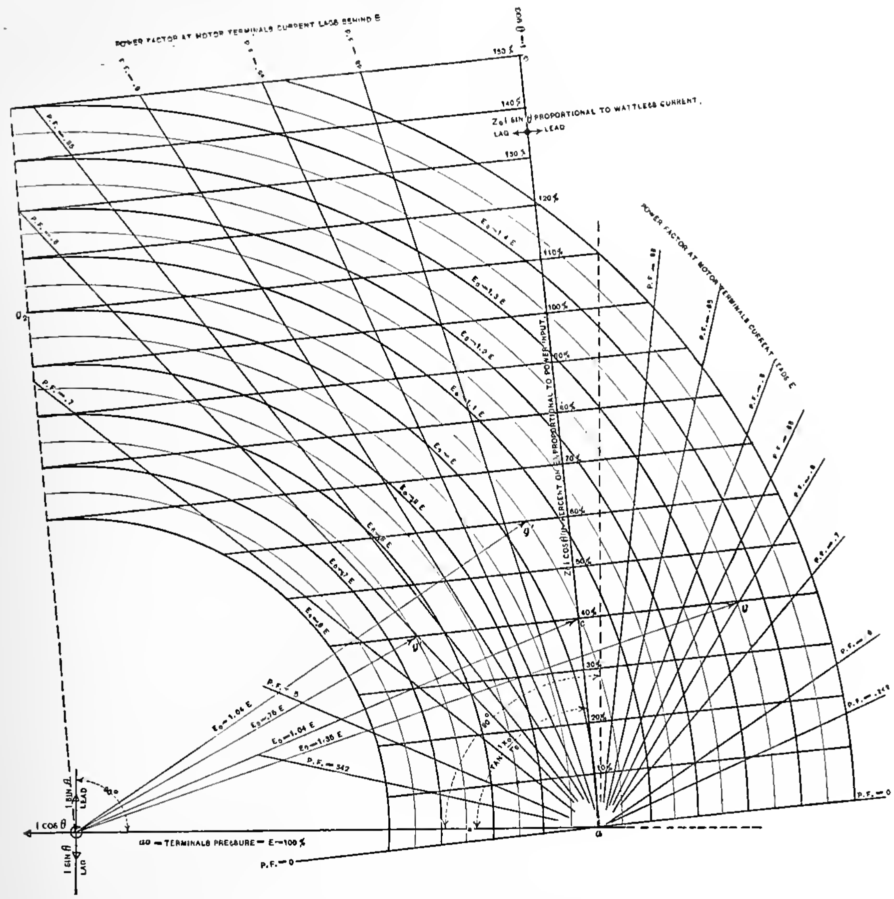


Fig. 10. Synchronous Motor Calculating Diagram.

the current. If a given motor consumes 40% pressure on full-load current, then the point 40% would represent full-load input into the motor. In the calculating device, points along *ac* are marked 1, 2, 3, etc., representing 1%, 2%, etc., of receiver pressure.

The following examples are given to show the use of the calculating device in making synchronous motor calculations. Assume that 40% pressure is consumed by the impedance by full-load current. In all the examples reference is made to Fig. 10; the results may be checked with the calculating device.

(1) Find the excitation which will give a power-factor of unity at full load. Go along *ac* to the point marked 40%, Fig. 10, and we see that the motor must be over-excited 5%. To give a power-factor of 0·8 leading current at full load, go to the point g: excitation equals $1{\cdot}34E$. To give 0·8 power-factor lagging current for the same load, go to the point g': excitation equals $0{\cdot}77E$. (Constant input means practically constant output, since the variable loss due to I^2r_0 will change very little.)

(2) What excitation will make the wattless lagging current equal to one-half the load current when the motor is carrying half load? Go along the line at right angles to *ac* at the point 20%, a distance equal to one-half the distance from *a* to 20%: excitation equals $0{\cdot}9E$.

(3) Suppose the excitation to be $0{\cdot}9E$ at one-quarter load, what will be the power factor and wattless current? The intersection of $E_0 = 0{\cdot}9E$ with the line at right angles to *ac* at the point 10% gives a power-factor of 0·7+, and a wattless current equal to the load-current.

(4) For any particular position of E_0, the electrical angle through which the motor must swing from no load to the new load corresponding to the given position of E_0 is equal to the

load capacity, etc., which are beyond the range of the calculating device, Fig. 10 is given. The angle betwen *ac* and *ab* is 84½°. Points along *ac* have been marked 10%, 20%, etc., corresponding to the percentage pressure consumed by the power component of angle between E_0 and E. (This assumes, that instead of the true self-induction and the magnetising or demagnetising effect of the armature, we may use the synchronous reactance.) The mechanical angle through which the motor must swing will be equal to the electrical angle divided by the number of poles.

(5) What is the maximum input when $E_0 = E$? Follow the circular arc $E_0 = E$ until we get maximum protection on *ac*. The projection on *ac* gives the load. The length along *ac* is seen to be 110 %. Therefore, the input (110/40) equals 2·75 times full load. The power-factor, as shown, would be about 0.75. The current in the motor is ag_2, and may be scaled off.

If E_0 is less than E, we see that the overload capacity, or the maximum load which the motor will carry, will be reduced. The overload capacity will vary inversely as the percentage pressure consumed by impedance. For example if another motor consumed 80% pressure on full-load current, then the point 80% would represent full load, and the overload capacity would be 110/80, or reduced one-half.

(6) To determine the V-curves between the excitation and current for the same input, we may proceed as in the following example: For full load, if $E_0 = 1{\cdot}05E$, the current is a minimum, and equal to the length from *a* to the point along *ac* marked 40%. If $E_0 = 0{\cdot}77E$ the armature current is ag^1. If $E = 1{\cdot}34E$ the armature current is *ag*. For any other load, move along the line at right angles to *ac* at the point corresponding to the load.

(7) Suppose this is the motor operating at the end of a transmission line, as explained before. At 65% load the motor was to be so excited as to draw non-inductive current, and at 20% load the power-factor at the motor terminals was to be 0·725. Going to Fig. 10, we see that to produce these power-factors the excitation at 65% load must be 1% higher, and at 20% load it must be 10% lower than the terminal pressure. If we assume the losses in the motor and its attached generator to be 10%, we see from Fig. 2 that the motor should draw, when delivering no load, 25% wattless current. In order that the wattless current taken by the motor at no load shall be 25% of the full-load current we see from Fig. 10 that the excitation at no load must be practically 10% lower than the terminal pressure. By setting the shunt excitation of the synchronous motor so that at no load the motor is underexcited 10%, and then adjusting the series excitation for non-inductive current at 65% load—that is, 1% higher than the terminal voltage—changes in load on the motor will have little effect on the line pressure.

The reader will have no difficulty in solving other alternating current problems. For example, the problems solved in Steinmetz's "Elements of Electrical Engineering," p. 44-102 and 121-162, may be solved very quickly with the device.

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

There is an indefinable fascination connected with a miniature reproduction of large things. A model of a steamship or of a locomotive is interesting alike to the layman and the technical man. For this reason the model four-kilowatt plant on the shores of Lake Tahoe is likely to prove as productive of comment as would a 40,000-kilowatt plant elsewhere. Incidentally the regulator with which it is equipped and which was specially designed for this plant, may prove applicable to larger installations.

From time to time in these columns have been published descriptions of the great hydroelectric power developments of the Pacific Coast. Accompanying each has been a map of its transmission lines, but these individual maps are an unsatisfactory basis for relative comparison. Hence it is believed that engineers and others will find the map of all the transmission systems of California and Nevada which accompanies this issue of great value. It is to be followed by others showing the same facts for the rest of the great territory "from the Rockies to the Coast."

From Portland, Oregon, comes notice of another electrical casualty which is directly due to police stupidity. Although every evidence showed that suspended animation was being restored by the energetic methods of resuscitation to which the victim was being subjected, yet an officious policeman ordered that he be placed in an ambulance which had meanwhile arrived. The patient died on his way to the hospital, whereas there was strong probability of his recovery if the good work which had been started could have proceeded without delay. Although proper means have now been taken to impress upon all members of the force the necessity for immediate and continuous action for the relief of electric shock, yet it seems to be a case of "locking the stable door after the horse is gone." Yet, if this instance can be sufficiently emphasized there is hope that other deaths may be hereafter averted.

The calculation of alternating current problems has become involved in such a mantle of mystery and a cloud of complexity that many practical men are deterred from attempting their solution. While the calculus is undoubtedly a powerful tool for attacking the question and while the physical significance can be made clearer to students by the aid of the higher mathematics, yet these same problems can be approximately solved by simple rules. We all crept before we walked and most of us are yet walking before we attempt to fly. We marvel at the mathematical flights of Steinmetz as we do at the aerial feats of Paulhan and the Wright brothers. Yet for practical purposes we are content wtih less spectacular methods. Among these is a time saver devised by F. G. Baum for

determining alternating current regulation and described in this issue. While it is not in the "creeping class," yet it is adapted for practical use.

The appalling life cost of coal is seldom considered when it is burned under boilers. Every industry has its hazards, but the life of the coal miner is particularly perilous. This week brings news of four more disastrous explosions, in Colorado, in Kentucky, in Mexico and another in Illinois, whose death toll is to be added to that of the Cherry mine last November. It is difficult to place responsibility for these accidents but statistics show that they are usually due to the carelessness bred of familiarity. It was hoped that the substitution of the incandescent electric lamp for the flame of the candle or inclosed oil lamp would eliminate much of the danger, but even electricity is not fool-proof. Notwithstanding our tremendous oil production and the increasing development of hydroelectric power, coal is likely to be our chief power source for years to come. Yet its present use seems little short of aiding and abetting wholesale murder.

Ballinger Investigation

The "Journal" has been struck by a line credited to the Chicago Tribune that "the country will stand by Pinchot right or wrong." The opinion of the editor of the Chicago Tribune is no better than that of any other well-informed man. We are prepared to say that while at first many were inclined to sympathize with the dismissed Forester the conclusion is being forced on the world that Mr. Pinchot deliberately planned to withdraw from the Forestry bureau, so as to be able to engage in the Ballinger investigation without being trammeled by official ethics. He is not to be blamed but praised for this.

It is also quite apparent that he determined not to resign and carefully planned a course of action that could only result in his dismissal by the President. He is to be censured for this.

This course was taken so as to bring upon the administration just the sort of unjust criticism that is now being levelled at Mr. Taft.

Mr. Pinchot would have been a bigger man, and would stand before the American people today in a more honorable attitude had he resigned and frankly stated his purpose to have been a desire to participate in the investigation of Mr. Ballinger. He felt that he could better serve the country in this connection than by continuing in public office. Then why not frankly say so and acquit the President.

As to Mr. Ballinger, we have already expressed our views. He is better off in private life. The country and its development have been retarded by Mr. Ballinger, and the whole question of conservation and private development on public lands has become so acute, so sore and tender as to preclude any rational settlement for years to come. The interests that sought Mr. Ballinger's appointment and imposed him upon the President were over greedy. The concerns that stand for fair treatment, honest development and ask only that which is fair to the government and the people, may well cry "A plague on both your houses."

Plant Depreciation

A full appreciation of the fatal meaning of depreciation is not granted to most of us until we try to sell a second-hand article. We are surprised to find that it became second-hand as soon as we paid for it, and from that time its value has continued to decrease. A thousand agencies seem to be at work hammering down its price. If it fortuitously escapes all these casualties which our insurance friends classify as "fire, earthquakes, storms, or other acts of God," it is liable to be superseded by some change in style or some improvement in method that renders it obsolete. Meanwhile it is constantly subject to the wear and tear of ordinary use, such destruction irresistibly driving it to its inevitable goal, the junk heap. Save for an occasional exception such as wine, a rare old violin or a fine painting, all things lose value with age.

Power plant machinery is not among the immune. A municipal electric lighting plant recently failed because its management had not allowed for depreciation of apparatus when they made the rates. After several years of successful operation, they suddenly became painfully aware that their plant was worn out. Plant replacement had not entered into their original calculations and in consequence it was shut down. This lack of financial foresight is not confined to municipal operations, for it is occasionally evident in the statements of private corporations whose directors are more interested in immediate dividends than in future deterioration.

Depreciation is a vital factor in the cost of doing things. Machine serviceability is strictly limited by its useful life. A certain part of its yearly earnings should, therefore, be annually set aside to provide for this replacement. If men invest in a proposition whose success is largely dependent upon the personality of its manager they insure his life to protect their investment. The useful life of a machine is even shorter than that of a man. Its rate of insurance should be correspondingly high.

The depreciation to which all classes of power apparatus is subject, has been accurately figured by competent authorities. It is a simple problem to apply these figures to the equipment of any power plant, and determine what provision should be made for deterioration. In many European countries neglect to take the ordinary precaution of reckoning depreciation before calculating profits is illegal. In any country it is morally wrong. It requires more honesty and more courage to write off from the books an obsolete machine than a bad debt. Yet one is as valueless as the other .

PERSONALS.

F. B. Crocker passed through San Francisco this week

Thomas Mirk, of Hunt, Mirk & Co., engineers, is in Los Angeles.

F. C. Greene, of the transformer department of the General Electric Company, is visiting the Pacific Coast.

John M. Gardiner, who is prominent in electric railway circles on the Coast, is in San Francisco from Los Angeles.

George R. Murphy, of the firm of Pierson, Roeding & Co., of San Francisco, has returned from a business trip to Seattle.

M. A. Bryte, Pacific Coast representative of the Sterling Lamp Company, has retnrned to San Francisco from a trip East.

F. D. Fagan, illuminating engineer, with the General Electric Company's San Francisco office, has returned from a trip to Stockton.

F. V. T. Lee, who has been assistant general manager of the Pacific Gas & Electric Company for some years past, has just resigned.

H. Vensano, who was for some time assistant to J. H. Wise, has been appointed civil engineer for the Pacific Gas & Electric Company.

I. W. McConnell has resigned as snpervising engineer, United States Reclamation Service to become chief irrigation engineer for J. G. White & Co.

William G. Kerckhoff, who is heavily interested in electric power companies in Los Angeles was a visitor in San Francisco during the past week.

Fred T. Mumma has been promoted from foreman of constrnction to superintendent of the Big Bend power plant of the Great Western Power Company.

W. A. Purcell, manager of the California Electrical Construction Company of San Jose, was in San Francisco during the past week, placing orders for supplies.

P. D. Frazer, constrnction foreman for the General Electric Company, has completed some high-tension transformer work near Tacoma and is now in San Francisco.

J. H. Wise has resigned as civil and hydranlic engineer for the Pacific Gas & Electric Company, to enter the firm of F. G. Banm & Co., engineers and constructors, San Francisco.

J. P. Jollyman, until recently superintendent of the Big Bend power plant of the Great Western Power Company, has been made electrical engineer for the company with headquarters in the Shreve Building, San Francisco.

Chas. E. Sloane, mining and irrigation engineer, E. B. Spaulding, electrical engineer, and F. T. Robson, civil engineer, have opened joint offices in the Union Trnst Building, San Francisco, as consulting and snpervising engineers.

K. G. Dunn, of Hunt, Mirk & Co., representing the Westinghouse Machine Company, left February 1st for El Paso, Texas, to make an economy test on the complete power plant, which his firm has jnst installed for the Southwestern Portland Cement Company.

G. R. Folds, general salesmanager of H. W. Johns-Manville Co., New York, has taken temporary charge of the San Francisco branch of the company as acting manager. C. W. Scott, the former manager, has been transferred to the Indianapolis office of the company.

Albert Spies has retired from the editorship of "The Electrical Record" to become the managing director of "Foundry News," a new illustrated monthly publication devoted to the foundry arts, with offices in the Hudson Terminal, 50 Chnrch Street, New York. "Foundry News" will make its first appearance in April.

CALIFORNIA METAL TRADES BANQUET.

About 150 members of the California Metal Trades Association celebrated the third annual installation of officers at a banquet given in the Palace Hotel on Saturday evening, January 29, 1910. J. M. Robinson, of the Keystone Boiler Works, was again installed as the association's president, S. J. Eva and Constant Meese, vice-presidents, and H. F. Davis, secretary. The general executive committee are: R. H. Postlethwaite, Risdon Iron and Locomotive Works, Potrero; John A. McGregor, Union Iron Works Company, San Francisco; John T. Scott, Moore & Scott Iron Works, San Francisco; Otto Schrader, Schrader Iron Works, Inc., San Francisco; George E. Randolph, United Iron Works, Oakland; William F. Murray, Murray Bros. Machine Works, San Francisco; George J. Henry, Jr., Pelton Water Wheel Company, San Francisco; Edward J. Fowler, Pacific Fonndry Company, San Francisco.

Three members for each of the craft committees were also installed, those for the electrical manufacturers' branch being: A. E. Drendell (chairman), Drendell Electrical & Manufacturing Company, Inc., San Francisco; H. T. Adams, Farnsworth Electrical Works, San Francisco; S. H. Weidenthal, Weidenthal-Gosliner Electric Works, San Francisco.

Geo. J. Henry, Jr., of the Pelton Water Wheel Company, acted as toastmaster, introducing each of the speakers and the various entertainment features. The speakers included Harris Weinstock, P. H. McCarthy and Jos. J. Tynan, the subjects discussed being industrial peace, home industry and the ship subsidy.

TRADE NOTES.

C. A. Maydell Co. have moved their offices from the Hansford Block to 409-11 Sheldon Bnilding, San Francisco.

Stone & Webster plans in the Northwest for 1910 inclnde a hydro-electric plant on White Salmon river, and thirty miles of internrban line between Bellingham and Mt. Vernon, Washington.

The Seattle-Tacoma Power Company are preparing to bnild a new power house at Snoqualime Falls. They are installing a 10,000 h. p. wheel, 7000 k. w. generator 2000 volt, three 2500 k. w. transformers. Stone & Wehster are the contrractors.

F. A. Hall, who for the past twelve years has heen manager of the chain block and hoist department of the Yale & Towne Mfg. Co., 9-13 Murray Street, New York, and Stanford, Conn., has resigned to become vice-president and treasnrer of the Cameron Engineering Company, of Brooklyn, N. Y. Mr. Hall's successor will he Mr. R. T. Hodgkins, who for several years has heen his chief assistant, and who is thoroughly qualified by experience and ability successfully to perform the duties of the position. In his new connection Mr. Hall expects to make a specialty of trolleys and appliances or overhead handling of materials.

NEW CATALOGUES.

Holophane Illumination for January, 1910, contains interesting information about scientific lighting from the Holophane Company.

The Jannary issue of Hot Points from the Pacific Electric Heating Company of Ontario, Cal., contains interesting data regarding the Standard Hot Point Iron for 1910.

MacGovern, Archer & Co., 114 Liberty Street, New York City, have issued their Febrnary list of second hand electrical and steam machinery, power house equipment, cars, etc., which they have for sale.

Catalogue No. 24 from the Chicago Fuse, Wire & Mfg. Co. is devoted to Fuse Protecting Material, including enclosed fuses, blocks and fittings, open link fuses, and fuse wire for all electrical purposes.

NEWS OF THE STATIONARY ENGINEERS

PREAMBLE.—This Association shall at no time be used for the furtherance of strikes, or for the purpose of interfering in any way between its members and their employers in regard to wages; recognizing the identity of interests between employer and employe, and not countenancing any project or enterprise that will interfere with perfect harmony between them.

Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the business of the Association, and at all times preference shall be given to the education of engineers, and to securing the enactment of engineers' license laws in order to prevent the destruction of life and property in the generation and transmission of steam as a motive power.

California.

No. 1. San Francisco, Thursday, 172 Golden Gate Ave. Pres., P. L. Ennor. Sec., Herman Noethig, 816 York St.

No. 2. Los Angeles. Friday, Eagles' Hall, 116½ E. Third St. Pres., J. F. Connell. Cor. Sec., W. T. W., Curl, 4103 Dalton Ave.

No. 3. San Francisco. Wednesday, Merchants' Exchange Bldg. Sec. David Thomas, 439 Merchants' Exchange Bldg.

No. 5. Santa Barbara. Geo. W. Stevens, 2417 Fletcher Ave., R. R. No. 2.

No. 6. San Jose. Wednesday. Pres., W. A. Wilson, Sec., Lea Davis, 350 N. 9th St.

No. 7. Fresno. Pres., A. G. Rose. Sec., E. F. Fitzgerald, Box 651.

No. 8. Stockton. Thursday, Masonic Hall. Sec., S. Bunch, 626 E. Channel St. Pres., H. Eberhard.

Oregon.

No. 1. Portland. Wednesday, J. D. Asher, Portland Hotel. Pres., B. W. Slocum.

No. 2. Salem. A. L. Brown, Box 166.

Washington.

No. 2. Tacoma. Friday, 913½ Tacoma Ave. Pres., Geo. E. Bowman. Sec., Thos. L. Keeley, 3727 Ferdinand St., N., Whitworth Sta.

No. 4. Spokane. Tuesday. Pres., Frank Teed. Sec., J. Thos. Greeley, 0601½ Cincinnati St.

No. 6. Seattle. Saturday, 1420 2d Ave. Pres., H. R. Leigh. Sec., J. C. Miller, 1600 Yesler Way.

Practical letters from engineers and news items of general interest are always welcome. Write your items regardless of style. Communications should be addressed to the Steam Engineering Editor.

CALIFORNIA NO. 3.

California No. 3 has been holding some very interesting meetings recently and several important topics have been discussed. The State License Bill which was brought up at the last State Convention in San Francisco was read, and adopted unanimously on January 19th, after some eloqnent remarks on the advantages of a license law by a distinguished visiting Brother, Phil Ennor, President of California No. 1. Bro. Ennor occupied the president's chair and conducted the initiation ceremony when Bro. Thos. Kennedy was admitted.

The many complaints made by the merehants of San Francisco concerning the smoke nuisance, led to a discussion of the best methods of reducing smoke to a minimum, and some very valuable ideas were advanced by a number of the members as to the proper method of firing. It was proposed that a committee be formed to make a special study of the causes of smoke and how to combat them so as to advise all engineers who may be desirous of information. This matter is getting quite serious, as the dense clouds of smoke which daily befoul our fair city will testify, aside from motives of economy. The subject will be thoroughly discussed before definite action is taken. Bro. R. F. Chevalier was present and gave his views on the subject. The committee on the Engineers' hall reported that arrangements were well under way. Bro. B. E. George of California No. 1 occupied the chair. All indications promise a very successful and enjoyable affair.

The following candidates were admitted to California No. 3 during the month of January: D. J. Rogers, W. B. Leigh and Thos. Kennedy, a number of other applications being on hand.

PRACTICAL MECHANICS.

Paper No. 6.

Before leaving the case of transmission between parallel axes we will cite some examples to illustrate the points brought out in the last paper. These have been taken from Robinson's "Principles of Mechanism."

Example I: An excellent needle bar motion for a shuttle sewing machine is obtained by link-work; and it is, without question, in one case, at least, the lightest running shuttle machine yet built, the whole machine being link-work mechanism.

The needle bar motion referred to is shown in Fig. 4, and is used in several different sewing machines. At A is a rocking shaft with a crank arm AD attached, the latter reciprocating between the angular positions AE and AF; the connecting link DB raising and lowering the needle bar BJ.

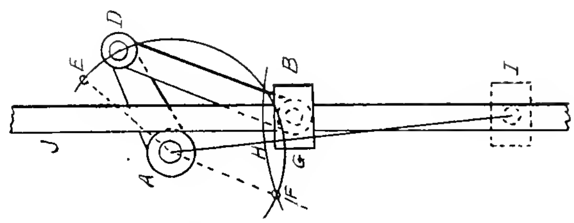


Fig. 4.

As D passes the line AI of crank and link straightened, the bar reaches its lowest position. As D moves on to its limit of motion at F the bar is raised an amount GH, forming the loop for the shuttle. Now it is not necessary for the needle bar to return to G, but on tarrying a moment raised to H for the shuttle point to fairly enter the loop, it may reasonably enough continue on its upward journey. By a cam it would be given this action, but by the link-work of Fig. 4 it *must* return to the lowest point again before making its ascent.

Now, if this drop by the amount HG, after the shuttle enters its loop, is fatal to the machine, the proposed link movement must be abandoned; otherwise it may be accepted, giving a much lighter-running and more durable combination than if the cam and pin be adopted.

Example II: Another interesting case of this is found in the Corliss valve gear, where the rocker plate swings to carry the pin D, Fig. 5, back and forth from H to F. The valve and stem

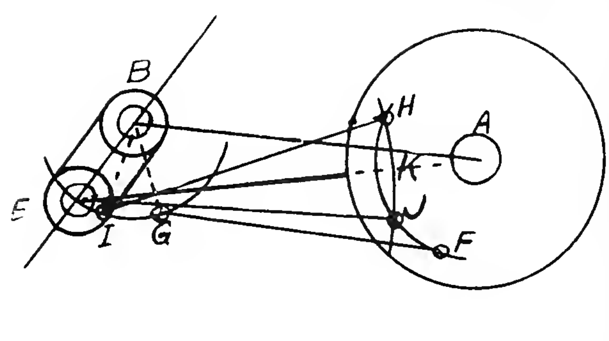
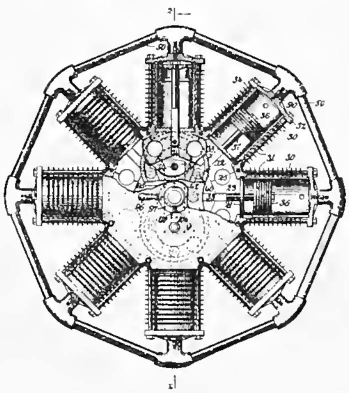


Fig. 5

B are moved by the lever BE as it swings from BE to BG. As D moves from J to F and return the valve is opened and closed, while from J to H and back it remains closed, but is compelled to be moving slightly, due to the arc JDH. If this movement represented by DK were out of the question, the link-work combination of Fig. 5 would have to be rejected; otherwise it may be accepted, as in fact it has been by hundreds of designers following in the footsteps of George H. Corliss.

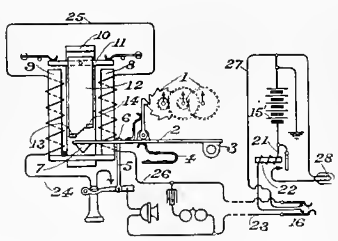
PATENTS

947,226. **Gas Engine.** George Dorffel, Fruitvale, Cal., assignor of one-half to William C. Clark, Fruitvale, Cal. In an internal combustion engine, the combination with a plurality of cylinders, their pistons and piston rods, of a shaft, a guide rigidly secured to the shaft, means at the end of



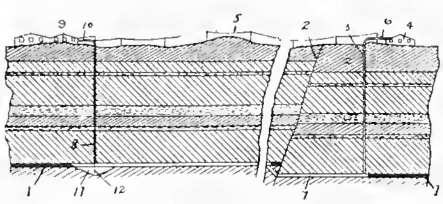
each piston rod for co-operating with said guide to rotate said shaft, and means for guiding each of said piston rods, the said means comprising a disk forming the inner head of the cylinder, and having an opening for the passage of the piston rod, and ears projecting from said disk and spaced from each other for the passage of the end of the piston rod.

947,335. **Connection-Registering Device for Telephones.** David S. Hulfish, Chicago, Ill., assignor to McMeen & Miller, Chicago, Ill. In a connection registering device for telephones, the combination of a counting train, a pawl adapted to operate said counting train when moving from one of its



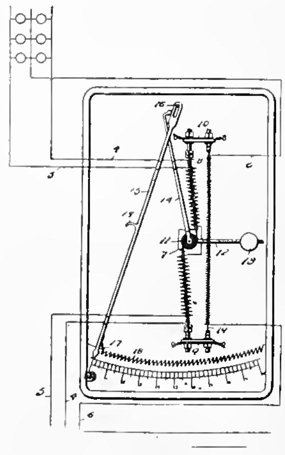
extreme positions to the other, an electromagnet adapted to hold said pawl in an intermediate position, and means associated with the telephone hook lever for restoring said pawl to one of its extreme positions when the hook lever is down, substantially as described.

947,608. **Method of Utilizing Buried Coal.** Anson G. Betts, Troy, N. Y. The process of utilizing unmined coal which consists in mining out part, and gasifying remaining coal by con-



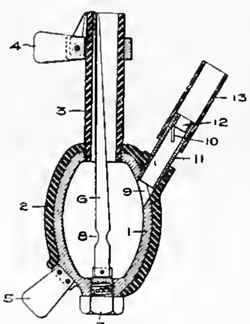
ducting air or equivalent gas thereto, which gasifies the coal and collecting the combustible gases resulting therefrom.

947,267. **Electrical Measuring Instrument.** Maurice J. Wohl, New York, and Harry Hertzberg, Brooklyn, N. Y. In an electrical instrument for three-wire circuit, the combination of an indicator pivotly mounted to permit a swinging movement and a longitudinal movement thereof, a serrated member over which said indicator travels, and serrations of said member being formed to permit said indicator to travel thereover in one direction but to hold the same against a



return movement, an operating member operatively engaging said indicator for movement in one direction only, means for moving said operating member in this direction, a thermally expansible wire operatively connected to said operating member, means for heating said wire by the current flowing in the outside lines of said three-wire circuit, a co-operating thermally expansible wire, and means for heating said last named wire by the current flowing in the neutral line of said circuit.

947,235. **Ventilated Fuse.** Edward M. Hewlett, Schenectady, N. Y., assignor to General Electric Company. In an



expulsion fuse, means for ventilating said fuse under normal conditions, and means for confining the blast of exploding gases to the region occupied by the fuse.

947,448. **Process of Reducing Iron Ores.** Charles B. Morgan, Oakland, Cal. The process of reducing iron ore into metallic iron, the same consisting in reducing the ore charged with its flux into a liquid condition, then withdrawing the liquefied ore charge and discharging the same onto a bed of asphaltum or liquefied carbonaceous substance which intermingles with the melted charge and separates the metallic iron from its attendant gangue or slag.

INDUSTRIAL

THE ELECTRICALLY DRIVEN PUMPS OF LOCKPORT, N. Y.

The city of Lockport, N. Y., derives its water supply from the Niagara River near North Tonawanda, thirteen miles away. From the electrically driven pumping station at this point, the water is forced through 69,000 feet of 30-inch main to a stand pipe 25 feet in diameter and 120 feet high, at Lockport.

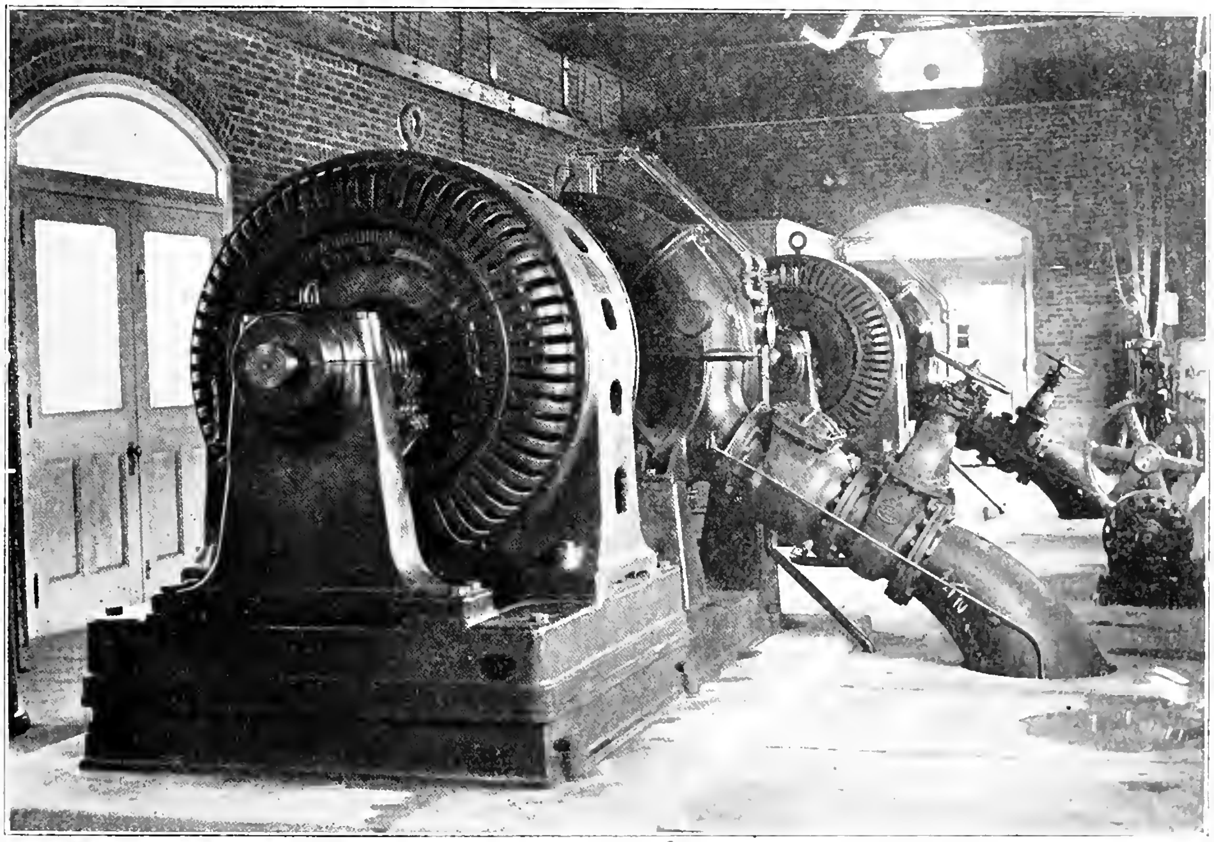
The pumping plant contains three independent units with a combined capacity of delivering 15,000,000 gallons in 24 hours against a pressure of 125 pounds. Each unit comprises a Westinghouse induction motor, designed for 500 h. p. at 750 r. p. m., with three-phase current at 400 volts, direct connected to a single suction, enclosed impeller centrifugal pump made by the Holly Manufacturing Company, Buffalo.

Power generated at Niagara Falls is transmitted to North Tonawanda at 22,000 volts and is stepped down to 440 volts at the pumping station by three 500 kilowatt, oil insulated, water cooled transformers.

The three motor driven pumping units were recently given a very complete test, which developed some interesting economics of electric operation. Each unit was run continuously for 15 hours, during which time readings of the electrical input were taken every five minutes; readings of the Venturi water meter every ten minutes; pressure gauge every five minutes, and revolutions of pump every fifteen minutes. The results are given in the accompanying table, which shows that all three of the pumps exceeded the duty requirement of 27,000,000 foot-pounds by approximately 4,000,000 foot pounds. It will be further noted that the temperature rises are well within the specifications, and that the pump capacities and horsepowers are well exceeded.

Result of Tests of Lockport's Motor Driven Pumping Units.

	Pump 1.	Pump 2.	Pump 3.
Maximum rev. per min. . .	746	752	744
Minimum " " "	738	738	739
Average " " "	743	744	743
Maximum gauge pres. lbs.	142.5	144.5	143.5
Minimum " " " .	119.5	139.5	134.5
Average " " " .	136.9	142.6	138.9
Average head, feet.......	315.8	329.1	320.6
Gallons pumped per hour..	238,000	236,300	236,700
Gallons pumped in 24 hrs. at this rate............	5,712,000	5,672,000	5,712,000
Kilowatt input per hour..	342.4	346.1	341.5
Gallons per kilowatt hour	1,454	1,464	1,413
Hydraulic horsepower....	318	327	319.5
Electric horsepower......	456.6	456	455
Efficiency per cent.......	69.6	71	70
Duty, foot-pound per 1000 k. w...............	30,800,000	31,600,000	31,000,000
Degrees temperature rise in 15 hours............	41	38	43



Electrically Driven Pump of Lockport N. Y.

In the case of the Lockport pumping station, electrical energy is purchased at $16.00 per horsepower year. The cost of power for this station is thus just about equal to that of steam operation under conditions assuming cross-compound pumping engines giving a duty of 130,000,000 foot pounds per 1000 pounds of steam; coal at $3.00 per ton delivered into the boiler room; 8½ lbs. evaporation under working conditions, and including labor for making steam and handling ashes, as well as increased fixed charges against the additional plant for operating with steam. This electrically driven pumping plant is thus developing duty equal to 130,000,000 foot-pounds per 1000 pounds of steam.

In connection with this plant which is pumping its output about 13 miles to Lockport, it may be of interest to note

that last summer when a large fire broke out there, eleven powerful fire streams through varying lengths of hose were maintained from the stand-pipe and pumps as long as needed for service. The entire water supply of which this station forms a part, as well as the station itself, were designed by Mr. Charles A. Hague, consulting engineer, New York City.

TIME INDICATED BY ELECTRIC FLASHES.

Long since has the "curfew tolled the knell of parting day." The school bell hastens the lagging steps of boy and girl; beautiful chimes remind us of the hour of service. the clanging gong calls the fireman to his post while the town clock, the pride of the village, solemnly announces the hour. Thus, in a hundred ways, are we reminded of time, or the passage of time, by tone long since familiar.

Town and tower clocks have been illuminated before now but it has remained for the highest office building in the world to flash forth the hours and the quarters.

There are clocks and clocks but giant clocks are not numerous. In the Metropolitan Tower, New York City, 346 feet above the sidewalk, is the largest as well as the most unique four-dial clock in the world, the dials of which are more than 26 feet in diameter. The huge hands weighing 1000 and 700 lbs. respectively, point to figures four feet high and pass over minute marks 10½ inches in diameter. At each quarter-hour the famed Cambridge chimes swell and roll over 1/16 of the population of the United States. The hours are struck on a 3½ ton bell with a 209 lb. blow, which is heard for many miles. Electricity drives this giant mechanism in an action entirely automatic.

As New York is not only a city of light but a city which demands light, night time finds the four dials of this clock brilliantly illuminated by more than 800 25-watt General Electric tungsten lamps, an equivalent of sixteen thousand candles. At any desired time hundreds of G. E. tungsten lamps appear behind the numbers on the dial, while the entire length of the hands, 17 and 13 feet respectively, is brilliantly lighted with a splendid effect which, it is stated, "has not been produced by any other clock in the world."

During the evening hours, the tower stands forth, a veritable pillar of light against the sky; but by far the most novel and interesting feature of either the clock or its lighting is the unique method by which the hours and quarter hours are "flashed" over the city and its environs. Seven hundred feet above the sidewalk is the terminal feature, a large octagonal electric lantern from which powerful flash lights mark the hours of the night. One, two, three or four red flashes mark the quarter hours, while the hours are designated by the appropriate number of white flashes. The lighting of this lantern is effected by 56 100-watt and 88 250-watt General Electric tungsten lamps, a total of 22,080 candle power.

The combined effect at midnight on eye and ear is not easily forgotten. Simultaneously with the swelling roll of the Cambridge chimes and the dozen deeper, hoarser tones of the great bell, the huge lantern flashes and scintillates like a giant jewel, now red, now white.

VULCAN EXHIBIT AT CHICAGO ELECTRICAL SHOW.

The Vulcan Electric Heating Company has one of the most interesting exhibits at the show on account of the demonstrations. These are all of practical value as the Vulcan devices are shown working under severe service conditions. The "Electrocurl" is being demonstrated by an expert hair dresser, and any lady so desiring may have her hair dressed in becoming style free of charge.

Vulcan "Electric High Temperature Soldering Tools" are being used on work of all kinds, both in their own booth and in that of the Commonwealth Edison Company. On account of their high speed and ease of operation the Edison Company are using them to manufacture many of their souvenirs. The Vulcan "Electric Marking Pencil" is shown for marking shipping cases, boxes, etc. This is another new application of electricity to heating, and practical demonstrations are being made on hard and soft woods. Red hot "Electric Branders" for wood, meat, leather, rubber and other materials are also shown in various styles and sizes, both as hand and power tools, and souvenirs are made on the spot with them. These souvenirs are of heavy paper, one of the most difficult kinds of material to brand satisfactorily.

Mr. H. H. Russell, sales manager of the Vulcan Company, is in charge of the exhibit and has several expert assistants. Mr. F. J. Holmes, president; Mr. G. W. Cravens, general manager, and other officers of the company are also present a large part of each day and evening.

TRADE NOTES.

Keeler, White & Co. moved their office and warehouse from 854 Mission Street to the Roberts Manufacturing Co. building, 162 Minna Street, San Francisco, on February 1, 1910.

The U. S. Dredge Chinook, to be used by the River and Harbor Commission at the mouth of the Columbia river, is being overhauled in the yards of the Marine Iron Works at St. Johns, Oregon. A large part of the upper deck will be removed to decrease the displacement. New boilers will be installed. The contract aggregates $130,000.

C. D. Andrews, wireless operator, who returned from Tahiti on the steamer Mariposa, brought the information that C. A. Ducarron is making a good beginning with a three-kilowatt wireless telegraph plant, the first to be installed there. The French Government has promised aid in extending the chain of stations to Fanning Island if the promoter effects communication between Papeete and Moketa. Thence the cable will complete the chain of communication between the south sea islands and New Zealand.

For supplying the motor-driven pumps of its municipal water filtration plant, the city of Cohoes, N. Y., has installed two Westinghouse gas engine driven, direct current generator sets, using producer gas as fuel. Both engines are of the three cylinder type 15x14 in. and develop 125 h. p. They are direct connected to two 75 k. w. 125 volt Westinghouse direct current generators. The output of these machines furnishes power for the motors driving the pumps of the city water supply, besides several other small motors about the plant, and the local lighting. The producer gas for this installation is derived from two 125 horsepower J-25 Westinghouse gas producers. The use of the gas producer in connection with the gas engine in a small plant of this kind is found to secure many advantages of economy, efficiency and ease in operation, over the equivalent combination of boilers and steam engines. The large number of such gas producer plants which have been installed in this country attest the increasing popularity of this modern type of power plant.

The Pelton Water Wheel Company of San Francisco report the sale of two Pelton-Francis horizontal turbine water wheels, frontal type, cylindrical encased, to the Washington Water Power Company, Spokane Falls Plant. Each turbine develops 1300 h. p. at 300 r. p. m. under an effective head of 65 ft., they being direct connected to alternators. The turbines are of unique design and consist of two approximately 36 in. runner to each unit, double draft tubes being employed together with two relief valves. The latter are of the Pelton mechanically operated type provided with adjustable oil bypassing devices so that the relief valves slowly close after the pipe line pressures have been restored to normal, incident to severe load changes. Both main bearings for each turbine are situated outside of the water chamber and are readily accessible for inspection, in fact all of the gate mechanism is situated on the exterior of the turbine casings. Owing to existing foundations in the power station, the Pelton Company's standard design was altered to suit same.

NEWS NOTES

FINANCIAL.

EL CENTRO, CAL.—The Board of Trustees has passed an ordinance calling a special city election to vote water bonds.

SAN BERNARDINO, CAL.—For the purpose of making improvements in a large tract of land in West Rialto the Fontana Water Company has voted a bonded indebtedness of $250,000.

CATHLAMET, WASH.—The City Council has passed a resolution providing for the construction of a system of waterworks and providing for the issuance of warrants to secure money for the payment of the same.

PASADENA, CAL.—Failure to secure the necessary two-thirds majority vote defeated the $1,000,000 water bonds $200,000 improvement bonds which were submitted to the people at the election January 27th.

NEWPORT, CAL.—Sealed bids will be received by L. S. Wilkeinson, city clerk, up to February 21st, for 40 bonds, $1000 each, known as municipal waterworks bonds, and 25 $1000 bonds, known as municipal light works bonds; both issues drawing 5 per cent interest.

COTTAGE GROVE, ORE.—Having found it impossible to sell the $100,000 five per cent water system bonds at par, there is a probability that the municipal council will renew its efforts to provide this necessary improvement by beginning over again. S. A. Kean & Co. of Chicago were the only bidders on the bonds.

SAN FRANCISCO, CAL.—The Russian River Light & Power Company has filed articles of incorporation with the county clerk. The corporation has an authorized capital stock of $300,000, divided into shares of $100 each, one share each being subscribed by the incorporators, J. E. Bennett of San Mateo, H. C. Eastman of Los Gatos, N. M. Twomey of San Francisco, E. R. Hough of Kentfield, L. R. Dickey of Alameda.

OAKLAND, CAL.—The People's Electric Light & Power Company has voted to issue bonds to the extent of $250,000. The bonds are to be 30-year 5-per-cent paper, to be dated July 1st, and are to consist of 125 at $1000, 200 at $500 and 100 at $250. In a statement of the original bonded indebtedness, the capital stock is given at $500,000, of which $300,000 is common and $200,000 preferred stock. All of the common and none of the preferred stock has been subscribed for. The officers of the company, which filed articles of incorporation two months ago, are: President, D. U. Toffelmier; Secretary, C. L. Best. The other directors are: J. H. Hornung, A. C. Sprout, E. W. Crozer and W. H. Spaulding. The purpose of the company is to establish a distributing plant near San Leandro.

SACRAMENTO, CAL.—With the filing of articles of incorporation by the East Sacramento Water Company it is announced that the board of directors of the company will meet next Tuesday for the purpose of completing plans for the coming year, select the district in the eastern limits of Sacramento upon which the company will first operate, take steps to apply for a franchise and decide on the size and kind of buildings which are to be erected at the water plant site. The directors are: H. J. Gothe, G. P. Beere, H. A. McClelland, H. Taubner Goethe, Thomas Oates, Peter Zingg and Albert Elkus. The capital stock is $205,000, and the principal place of business is Sacramento. It is the purpose of the company to supply water, gas and electricity for use in Sacramento county, particularly that section east of, but excluding this city. It is probable that Elmhurst, a new tract opened east of this city, will be the first to be supplied.

TRANSMISSION.

KENNETT, CAL.—Electric power is to be used at the Uncle Sam mine, which is now operated by I. O. Jillson and J. A. McIntosh, with L. C. Monehan in charge as superintendent.

SPOKANE, WASH.—Bids for two transformers for use in the up river pumping station have been opened by the board of public works as follows: General Electric Company, $8200; Westinghouse Electric Company, $7175; Allis Chalmers Company, $6710, and Dixon & Kimmel, $7095.

RED BLUFF, CAL.—A notice has been filed in the county recorder's office by W. F. Luning, who lays claim to 12,000 inches of water in Hill Creek to be diverted near the corners of sections 21 and 22 in townships 27 north, range 2 east. The water is to be used for generating electric power.

FRESNO, CAL.—William S. Douglass and C. M. Russell have appropriated the water flowing in Fish creek at or near 6-5-27, four miles above its mouth to the amount of 1200 second-feet. A diverting dam is to be built, the water will pass through a tunnel 8x7 feet and three and half miles long.

LAIDLAW, ORE.—H. H. Humphrey of Kennewick, Wash., and Mrs. Carra Kirkham-Swafford have bought the two Awbrey Falls and the B. F. Nichols Falls on the Deschutes river close to Laidlaw ,the consideration for the power site being $50,000. The purchasers intend to develop the water power of the falls, which is estimated at between 40,000 and 50,000 horsepower.

PACHUCA, MEX.—A concession has been granted to Lic Alonso Mescal y Pina for the utilization of the waters of the Lake of Metztitlan, State of Hidalgo, for the generation of electric power. The concession also includes the drainage of the lake. A company to take over the concession will be styled as Empress Irrigation de la Vega de Metztitlan, Estado de Hidalgo.

EUREKA, CAL.—Surveyor J. N. Lentell has filed water appropriations as follows: 300 inches in a creek at crossing of Mountain View-Lone Star road near McBride's; 300 inches in a creek through Sec. 5, 3 N., 3 E., ¾ of a mile from McBride's gate; 300 inches in a creek in SE. ¼ of SE ¼ of Sec. 30, 4 N., 3 E., and 200 inches in Mad River about 200 ft. below the mouth of Bug creek. He plans to develope electric power for use in this city.

TACOMA, WASH.—Sealed proposals will be received at the office of the Commissioner of Public Works till February 21st for constructing the headworks and tunnel for a hydro-electric power plant on the Nisqually river, work to consist of a concrete diverting dam, intake and channel, with necessary screen and gates, and a concrete lined tunnel 10,015 feet long. Plans may be obtained from the office of the chief engineer, Tacoma, upon depositing $30. The estimated cost of the work is $657,575.

MANTON, CAL.—Notwithstanding the fact that the Northern California Power Co. laid off over 500 men here when the snow began to fly, it still has 350 men on its Manton pay roll. Most of these are at work on the tunnels through which water will be conveyed to the power plant at Inskip. The water will pass through four tunnels, the longest of which is 4300 feet. Another tunnel will be 1500 feet in length. The power plant at Inskip is rapidly approaching completion. All the machinery is on the ground and much of it is in place. When the weather moderates and a full force of men is at work again it will only take about a month to put everything into shape for starting the plant.

TELEPHONE.

SAN FRANCISCO, CAL.—The Home Telephone Company has officially announced the opening of long-distance service between San Francisco and Oakland.

MODESTO, CAL.—J. C. Davis having petitioned the Board of Supervisors to erect and maintain a telephone line along the Maze road and said Board being fully advised in the matter, orders that said petition be granted.

YREKA, CAL.—The Supervisors have ordered that petitioners asking for permission to erect a telephone line between the Klamath Hot Springs and the Con Malloy ranch on Willow creek, be granted permission. The line to be known as the Ager, Hornbrook and Bogus Telephone Line Co.

LOS ANGELES, CAL.—Three dangerous railroad crossings on Aliso street and on either side of Los Angeles river bed are to be protected with electric alarm bells according to present plans of the Board of Public Utilities who have recommended to the City Council an ordinance providing for the installation of bells.

PORTERVILLE, CAL.—The old telephone line purchased several months ago from the Sunset Company by J. C. Danner of White River, and which is being replaced with a metallic circuit phone line, has been purchased by farmers of the Bear creek and Poplar districts. A. J. Saladay and H. S. Bachman are financing the deal.

OAKLAND, CAL.—Lincoln Park will be the location of the new building to house the department of the fire alarm and police systems of Oakland, under an expenditure of $45,000, as authorized in the bond issue, providing City Attorney J. W. Stetson finds no legal obstruction to the terms of the grant to the city of Oakland of the park property. The Board of Public Works and the Board of Fire Commissioners have agreed upon the excellence of the site in respect to proximity to the business district and the present system of cables, and it is proposed to erect a one-story structure of concrete.

OAKLAND, CAL.—The Home Telephone Company of Oakland intends to spend $500,000 in the extension of its system to Alameda, according to the announcement of T. C. Craig, the local manager. A separate exchange centrally located in Alameda, a system of underground wires contained in damp-proof cables and one-party lines connecting direct with the switchboard will be the features of the system in Alameda. The main cables connecting with the Oakland office will be run under the estuary near the Webster street bridge, but will be sufficient in number to allow every person securing an Oakland, Berkeley or San Francisco number without loss of time.

ILLUMINATION.

HALSEY, ORE.—Geo. Taylor of Eugene, is planning to install an electric light system here.

ELLENSBURG, WASH.—The power canal of the municipal light plant is to be enlarged with a view of improving the service.

WENATCHEE, WASH.—Plans are being considered by A. J. Linville and others of this place for building an electric railway system to serve this place and the county as far as Leavenworth.

KALISPELL, MONT.—It is announced by J. A. Edge, president of the Whitefish & Polson Electric Railway Company, that a line will be surveyed at once for connecting the Northern and Southern ends of the county.

PHOENIX, ARIZ.—The Southside Gas Company has awarded a contract for the construction of a gas plant here to E. A. McGillivery of Los Angeles. The cost of the plant will be between $35,000 and $50,000. It is to be completed within four months.

IDAHO FALLS, IDAHO.—It is reported that the holdings of the Idaho Power & Transportation Company have been disposed of to the Byllesby Company of Chicago and it is stated that this company will begin heavy improvements at an early date in connection with the construction of electric roads, etc.

STOCKTON, CAL.—The farmers in the district comprising French Camp, Lathrop, Manteca, Ripon, Atlanta and Escalon have formulated a plan to secure electricity to run their irrigating plants and for lighting purposes. An enthusiastic meeting was held recently at Manteco, when a committee consisting of C. I. Salmon, Charles Brignoli, D. O. Castle, J. S. Moulton, J. N. Leighton, and I. Miller, which had canvassed the district reported that 1.095 horsepower had been conditionally pledged.

GEORGETOWN, WASH.—The Seattle Lighting Company has completed the purchase of property owned by the Hofius Steel and Equipment Company and will begin the erection of a sub-station including a large gas holder with a capacity of one million cubic feet and a two-story office building within the next sixty days. The expenditure for the holder will be $125,000. Five miles of mains will be laid here, while South Park, Youngstown and Rainier Valley will be served from this point.

TRANSPORTATION.

FULLERTON, CAL.—Between 25 and 30 carloads of railroad building material is being unloaded in La Habra valley and is to be used for the extension of the electric line east toward Olinda and Yerba.

EUREKA, CAL.—Estimates made on the cost of constructing a proposed electric railroad between Eureka and Redding or Red Bluff place its cost at $7,000,000. According to E. E. Skinner of the committee of ten Eureka business men now investigating the proposition, the building of the line is perfectly feasible.

ALAMEDA, CAL.—The ordinance granting the Southern Pacific Company a franchise to construct and operate an electric line from the High bridge to the loop in the east end has been given its final passage. The railroad company is to run trains from the lower part of the county through Alameda to the local mole and the above mentioned franchise is for a part of this system.

SACRAMENTO, CAL.—Two propositions for an increase in salary have been submitted to the local Street Railwaymen's Union by the Sacramento Electric, Gas & Railway Company, which were sent at once to the International President for approval. The substance of the increase is a raise of about 2c per hour. Men employed for the first year as motormen and conductors receive 27c an hour now, two years 28c, three years 29c and all over four years 30c. The increase means about $5 a month more to the street car men than they are receiving at present.

BERKELEY, CAL.—Work is being rushed on the S. P. electric system which completes the Berkeley loop system in this city. The tracks have been laid on Main street and the street work is now under way. Attorney Hobbs for the S. P. Company was before the Trustees last week with the request that the work being done in completing the street in the hands of the city and the land companies be expedited as far as possible. The two lines from the extension of the Shattuck avenue line in Berkeley and the extension of the California street line have already been pushed into Northbrae and Berkeley Heights and the lines of rails are converging toward this city toward Main street. The Ninth street line is soon to be connected, to connect with Jackson street in this city. There is a prospect, according to S. P. officials of the roads being ready for operation in 12 months from the present date.

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JOURNAL OF ELECTRICITY
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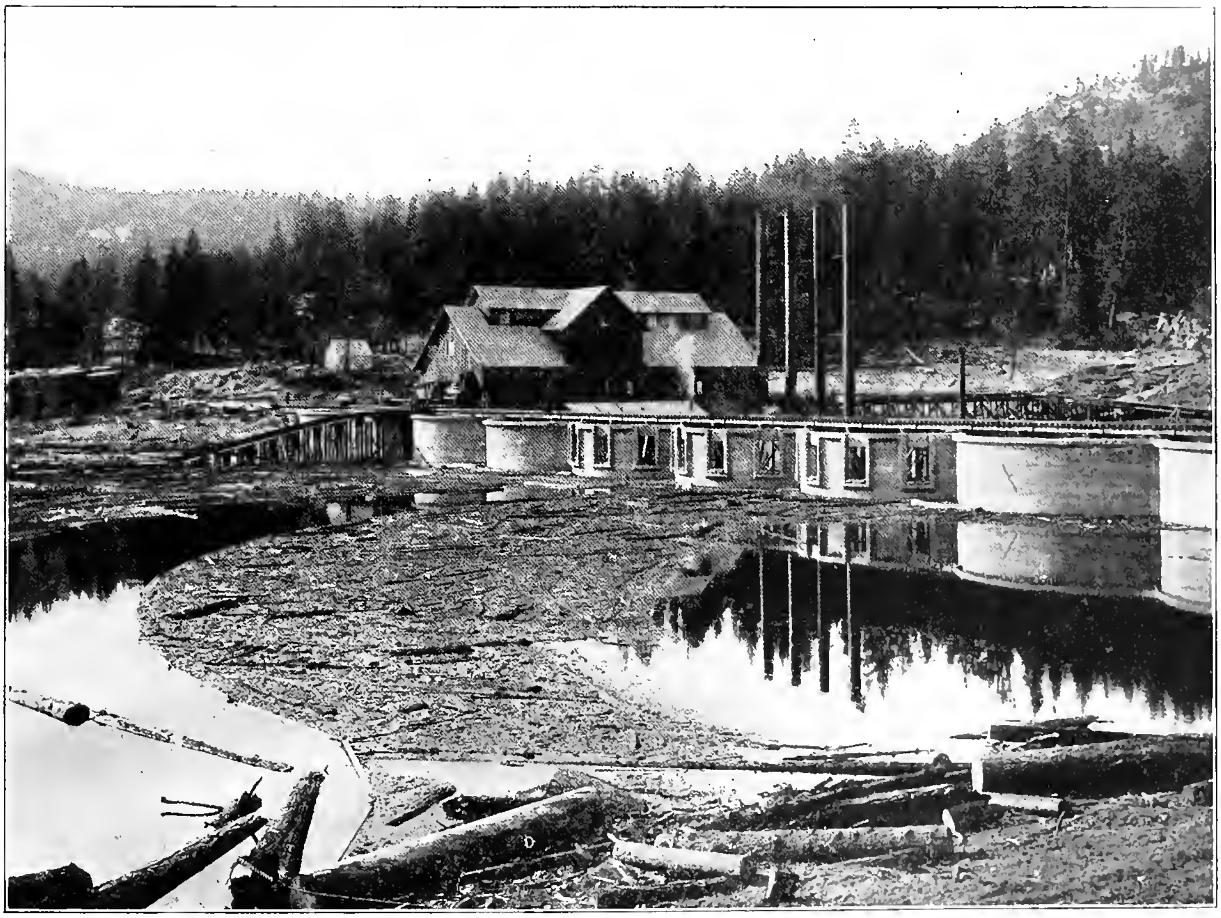
VOLUME XXIV | SAN FRANCISCO, FEBRUARY 12, 1910. | NUMBER 7

HUME LAKE MULTIPLE ARCH DAM[1]

BY JOHN S. EASTWOOD.

Since the publication of the description of the multiple arch dam at Hume Lake, near Sanger, California, a number of suggestions and criticisms have been received from several engineers.

With regard to that of Mr. Hugh L. Cooper, it is pleasant to have one's work appreciated where the ring of it is genuine, and, as most of us in the profession are obliged to accept it at par as a part of our



Multiple Arch Dam at Hume, California.

compensation, in addition to a modicum of coin with which to fight the wolf, to be of intrinsic value it must be genuine.

At the outset I wish to thank these gentlemen for the kindly spirit manifested in the discussions and I will answer them in the same spirit, which it is the belief of the writer is the true spirit as between members of the same profession.

On the next page is presented a diagram of the resultant thrust of the combined water and structure load; its position relative to the center of resistance

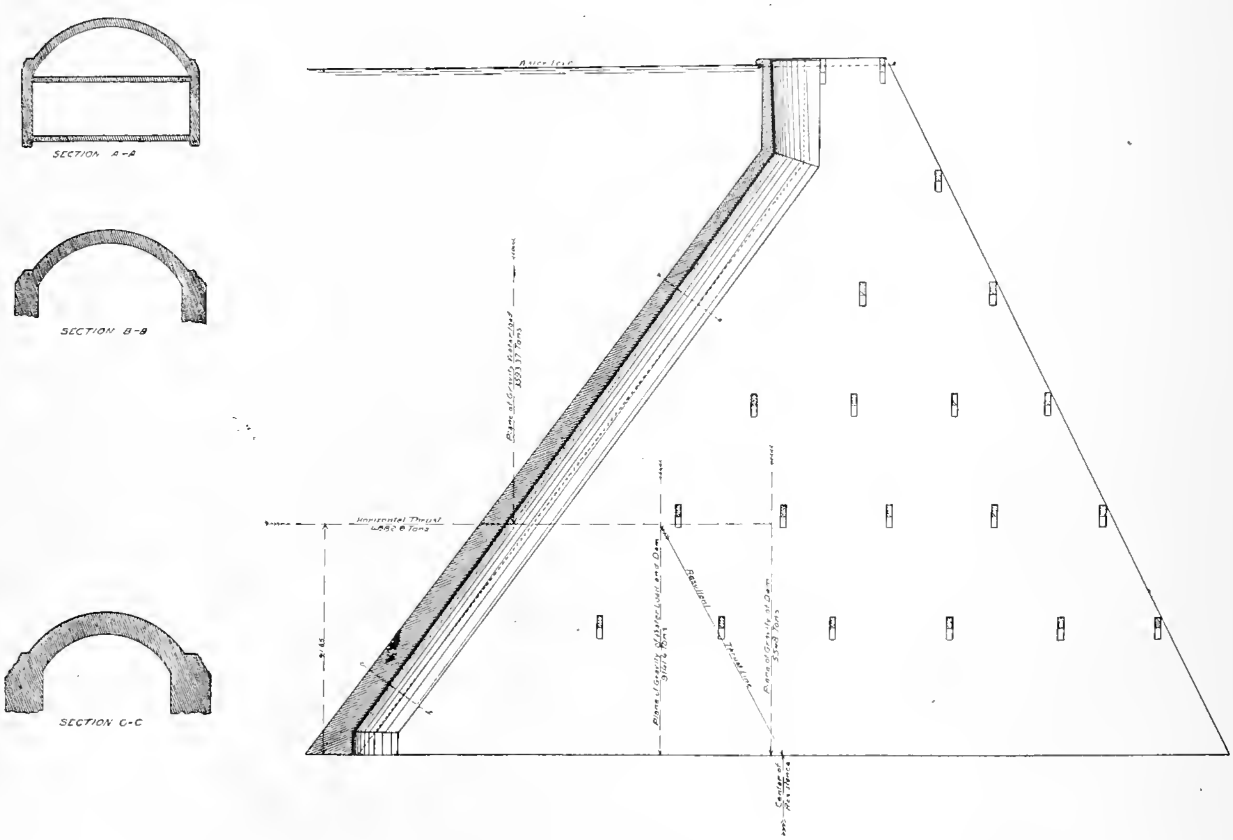
[1] See Journal of Electricity, Power and Gas, Oct. 30, 1909.

ance of the base, and as the angle of friction of sonry surfaces. As the stresses at all points above the base are less than at the base, owing to a uniform taper from the required base dimensions to resist the loading to the top, where the mechanical requirements of a considerable thickness with no load are met, all parts of one of these dams are stronger than required except at the base, and it is for this reason that the best economy can be had with a reasonably high structure, wherein the influence of the required top dimensions would have the least influence on the amount of material. This fact makes it the type for any structure within the limits of dam construction, as it will not approach near to that of a solid dam within these limits, and that, too with safety factors unattainable in a solid dam.

The weight on the buttresses is the weight of the water due to its depth plus the weight of the part of the structure sustained, or is span x pressure + the resultant of the arch ring weight, all in similar units. The Hume Lake dam is overstrong in all of its elemental parts, the greatest stress being in the middle arch ring near its base, where it is 187.5 pounds per square inch, or 13.5 tons per square foot; consequently the weakest place in the dam is 100% overstrong, all the remainder more so.

The present season has also been propitious in furnishing us with a test flood for the Hume Lake dam, there being a discharge through the wasteway gates of over 4600 second feet, the highest in thirty years, sweeping the canyon below as clean as a shotgun barrel. Mr. D. W. Decker, manager of the Hume-Bennett Lumber Company, in reply to a query as to the effect on the dam, replied, "There is not a sign of a crack in it and it is as tight as a bottle."

When asked by the average citizen what holds the dam in place, I answer, "The water," and when they ask what I am going to fill it with between the buttresses, I answer, "Wind," this being the paradox—water to hold it down and wind to hold it up. But, persiflage aside, the very simple laws of hydrostatic pressure met with a provision for the equalization and conveyance of the stresses set up by them to the foundations is all the "bump" the mathematics get; the equable distribution and support of known loads well within the known strength of the material used.



Stress Diagram of Multiple Arch Dam

In replying to the question of cost raised by Mr. F. O. Blackwell, I desire to emphasize that one of the principal advantages of this type of dam lies in the fact that for a given safety factor at the point of maximum stress, there is less material than in any other type for a given stress. This economy in materials leads to like economics in excavation, contractor's plant, crew, camp equipage, superintendence, and to the saving due to time saved in its erection, interest on uncompleted investment and putting into service, all of which offset the additional unit costs of placing the

material. It is not surprising that the unit cost was as low as it was in this case. The plant was all old except the cars and track, of too small a size for economy, and the power plant was of much-used logging donkeys, none of which stuff was up to the standard for a construction plant. With up-to-date apparatus, designed particularly for this class of work, the writer believes he could discount the costs of the Hume Lake dam by a considerable amount.

The form detail is shown in the cuts accompanying the original article, the form being built up ahead of the work so that the gangs would not interfere with each other. The method used, made the curved form work quite as simple as the buttress forms, the men erecting them as easily as a common house frame and boarding, much of the work being performed by common labor. The fact that lumber was but $10 per 1000 feet b. m., made it unprofitable to move any but the studs and one-inch boards in the buttresses and the liners of the curved forms, in so far as they could be used twice. The cost of cleaning, moving and refitting, considering the grit on it, made it so close as to be doubtful economy to move the forms.

As regards Mr. C. E. Grunsky's question as to the scope of this type, it is very much to be doubted if the failure of two structural dams make it wise to discredit all structural dams, the two cases cited being in both cases of avoidable reasons. These dams (the Pitsfield, Ambursen, and the Hauser Lake, steel) were both set on a water-bearing gravel stratum, and any other type would have been as great or worse a failure if set on the same insecure foundation (see Fergus' Falls dam). The very fact that a structure of this kind can and should be so designed as to distribute the load equally to all parts of the base makes it easier to support on a soft bottom than a mass dam. If cut-off walls are carried down to a sufficient depth, however thin the toe of the dam and weep holes provided in the base, there need never be recorded failures of this kind. Of course, solid rock foundations are to be preferred, and as they exist at most sites but a short distance below the surface, the very narrow cutting and inexpensive stripping should make it in most cases an easy thing to do right.

The matter of making concrete walls watertight is a feature that is dependent on composition and quality rather than quantity. Some instances of concrete tanks that are tight with water pressures almost as great as that at Hume Lake dam, though the walls are but eight inches thick, support this statement. With so many waterproofing devices in the market, many of which are of high merit and easily applied, it is rather more diffcult to decide between so many good ones than to make watertight the thinnest wall that is stiff enough.

The economical arc for the arch ring, like some of the other features of this type of dam, are determined according to a formula which fits the theoretical conditions of the factors from which it is derived, but which for practical reasons are at a slight variance from these in as much as their variance is affected by the requirements for mechanical reasons that do not appear in the theory.

Thus, while the economical arc for the Hume Lake dam, counting from center to center of the buttresses for the arc of extrados, based on a theoretical section, is about 136°, while for the heavy top it is found to give a very close result at 126° 28′, an angle obtained by taking the nearest even foot for the radius of extrados, the difference in quantity varying in so slight an amount for this variation in arc as to be negligible, while giving an even radius.

The filled between the arches is a feature that is for looks, as it does not add to the structure except by its weight, and hence is optional. The theoretical arc formula assumes the buttress and the arch ring to be sections required for the water pressure at the base and tapering to zero at the top, where there is no water pressure, the arc of extrados and intrados being equal, but in practice the altered batters to give a top thickness will make a different degree. The thinnest wall for a given thrust is at 180° of arc but it will contain about 8 per cent more material owing to increased length, being in a varying ratio to the decrease in thickness required for an equal load. The influence of the arch ring also affects the buttress thickness, and if an arc of 180° is used, the span must be increased to give the buttress its economical span load, owing to the change in the direction of the arch thrust.

The span is the flexible element in this structure and it puts it in a class by itself, the basis of the design being the concentric arch ring as a water face, allowing a closer adjustment of distribution of stresses while fitting the requirements of practice for such a structure.

The economical span is determined by the economical arch, and may be computed in terms of height or of span, the span being in even terms gives a multiple for spacing, the height in even terms giving odd spacing. All of these elements of the design must have a just weight in the design of a structure for any given site.

The slopes of the water face affect the quantities in the arch rings as indicated in Mr. Grunsky's table, due to the increased length of the arch, the least material being in a vertical arch and increasing in length as the secant of the angle of slope.

As the slope is influenced by a different set of factors, the economical slope for the theoretical section, varied by the other influences, is the slope for the practical structure, which is the one giving the mean of the influences of the requirement for stability, shear and distribution of stresses as well as the ultimate economy in quantities. The front and rear slopes required for stability will vary, the one increasing while the other is decreased for a given degree of stability, the increase of one calling for a decrease in the other in proportion to their degree of influence of the ultimate economical slope.

The tapering of the buttress from the water face toward the back while theoretically correct for a vertical face, becomes less with increase of slope, is counter to the requirements of keeping the center of resistance as far from the face as possible, and will not give the required shear strength. Hence is inoperative in practice, this also making the column method impracticable.

There should not be so wide a variation as from

1/5 to ½ of the quantities in a solid dam if a multiple arch structure is designed with due regard to the economics of materials resulting from giving to each feature its true value in the design. Of course there can be no question but that the unit costs for this class of work will be higher, a high degree of quality of materials and workmanship being required. But as the difference in cost between good concrete and bad or indifferent concrete made from the same materials is more a matter of good specifications and inspection than cost of materials, the greater part of the added cost being due to the form work and the difficulty of placing with apparatus designed for other conditions. The writer has gone quite thoroughly into the subject of the design of apparatus and forms, with especial thought to cheapen and simplify still more the construction of this type of dam, and is convinced that a still further reduction in unit costs is possible without any sacrifice of quality.

There is another paradox in this dam, that when it is fully loaded it is safest from stresses tending to rupture it, these being the temperature change streeses. Likewise when empty it is in greatest danger. We reinforce it with steel for stresses that can only take place when it is empty. If it were full all of the time it would not need any reinforcement as all of the load is in compression both full and empty, but when full they are an offset as well as a preventive of temperature changes.

Where the unit costs of concrete are high and the costs of steel are moderate the steel becomes as cheap as concrete in compression, and as it makes the structure safe from rupture, is advisable in any case of thin wall construction. The feature of using a water face, the material in which is all in compression makes the arch as a water face cost less than half the cost of slab construction for equal safe loads and spans, as well as putting the load on a material hunt by time, allowing other additional savings owing to its flexibility of span and reduction in number of buttresses.

These features place it in a class adapting it to a range of usefulness from very low structures to the highest that will be required for any site before its cost for a given strength approaches that of a solid type. It therefore becomes the logical type of dam for any height at any site.

As the critical point of stability comes in near the top, the vertical head is for the purpose of gaining width of top without adding to the buttress width of top or changing the batter of the back line of the buttress. It is a feature of the Hume Lake dam that is more prominent because the span is large. It is higher than it would be for a smaller span and is a larger proportionate part of the dam. The lack of rise in the economic span for a high dam requires the reduction of head as well as the increase in width to the buttress top. The head should be a curve on the extrados crown line, but the limitations of practical forms must be recognized and the structure made to fit as nearly as these will permit to the theoretical skeleton.

The Hume Lake dam, while 87 per cent overstrong for its service, using Mr. Grunsky's figures of 350 pounds per square inch in compression as a basis, is still a symmetrical structure in the main features, the departures from the highest safe economy being due to the service it is to perform. The spillways at the middle are to allow the use of the ground at either end as building sites for the mill and shop. As the openings cut out so much of the arch it necessitated the heavy walls. The fact that Sequoia logs 14 ft. in diameter are to be handled over it and in the pond, led to the design for an excess of strength.

The only redundance or of parts not in full service are those for eye sweetening the design, such as the filler, the coping and the wing buttresses, all of which are of more or less service in addition to what they could have as a part of a solid type, for stiffening, where such stiffening is of value to the structure.

Mr. Jorgensen is correct as to the economical arc for the theoretical structure. The formulae for this computation depend on whether the arch is supposed to include the triangular end of the buttress or whether the buttress is considered to be cut off at the spring line of the intrados of the arch. The result is the same in any event.

The economical arc will vary with the depth or water pressure, but as it will complicate the design to vary both the arc of intrados and of extrados, the economic arc for the practical arch is best taken as the mean of economy for the structure, the economic arc for the mean mass depth, this adopted as the extrados arc, letting the variation take place in the arc and radius of the intrados.

The theoretical arch would have to vary at all points in all of its elements and would complicate the design to the extent of making it more difficult to erect than the saving in material would warrant. There will be cases where a less arc will be more economical, such as where the least allowable thickness is in excess of the required strength at the ordinary economic arc, in which case an arc to fit the stresses is to be chosen.

Mr. Jorgensen has also struck the keynote of the principle of the design of this type of dam namely: load the entire structure to its greatest practical economy, getting the best efficiency with the least cost.

Mr. Wegmann's citations of the examples of works embodying to a more or less degree the principles of the arch in dam construction are interesting as showing how old the first conception of merit in the arch really is, of the problematic value of a patent on such a device. All of these earlier attempts at the use of the arch, which the writer hereby admits were rays of light on his patch, were the gropings for the structural idea in dam construction, and were indices of the direction in which to look for the ultimate structural type.

The earliest example was wrong in that the axis of a multiple arch dam should be straight instead of on a curve up stream, or if curved it would be better if curved down stream as adding to its stability, owing to the uptilting of the buttresses on the sides rather than the placing of them on an incline by the reverse method.

There is this to say about these earlier plans and works, they are all based on the idea that the water loaded arch is subjected to the same stresses as are set up in an arch when used as a cantilever or beam with a distributed load, and an arch designed in this form is not the true form, as the material outside of the crown

line of extrados is not only wasted and an added dead load, but the change in the direction of the thrust line reduces the efficiency of the materials making it a bracketed beam and introducing tension.

The Dillman design was good as showing the feature of cutting out a part of the material by widening the base, the water face of the arches being a vertical slab, the arch intrados eliptic, the buttresses tapering to the back. But it was only a step ahead, the same fault of making it a mere obstruction remaining and the stresses not being all compressive. Neither was it possible to give it an even base load any more than it is possible to give a solid dam a distributed base load. For this reason there is no doubt but that a buttressed dam 160 feet high with vertical arches would show but a small percentage of saving over a dam of solid section because it is the adherence to the old idea of the imposition of mass to resist a thrust instead of designing a structure to carry this thrust as a load to hold it in place.

While the structural principle is not so pronounced in the Hume Lake dam as it would be in a structure 160 feet high, it is because the heavy section and large spans due to the low head decrease the required slopes. The vertical arch is applicable in the multiple arch dam to such parts as are below the economic height for the head in structures where parts are high, and also for all arches where the height is such that a large span must be used for economy and for site where the canyon walls are close enough and steep enough to serve as abutments where they can be used to any required height.

This type of dam differs from the Ambursen dam, as shown in the reply to Mr. Grunsky's discussion, and as shown therein is not subject to limitations of height.

The writer, anticipating this question of watertightness has devised a method of making a practical watertight wall, regardless of water pressure or thickness of wall required in this type for the load stresses.

There is an erroneous idea as to the difference in the unit quantities in this type of dam and a solid type, due largely to a mental habit of classing it in with all other hollow types, instead of comparing it as an individual type. Mr. Grunsky places it at from 20 per cent to 50 per cent and Mr. Wegmann at from 85 per cent to 90 per cent of that of a solid dam but in so doing they are not comparing this type, but the design they have in mind, their own, which is not of this type.

To illustrate, the entire 2207 cubic yards in the Hume Lake dame, + 10 per cent to approximate the larger figure, = 2408 cubic yards. A solid dam would approximate 75 cubic yards per lineal foot of dam across the middle section of Hume Lake dam, and 75 into 2408 is 31.4 = the number of feet the quantities in Hume Lake dam would build of solid dam at the same site, and yet the Hume Lake dam, 667 ft. long, contains an excess quantity, based on Mr. Grunsky's allowable stresses, which are very conservative, of 87 per cent at its weakest point.

Because there is such a marked difference in quantities, the quality of the materials and workmanship can be made first class, the safety factors in all of its parts left far above any possible requirements, and still bring the cost far below that of any other type of structure for the service required.

CO-OPERATION BETWEEN ELECTRICAL JOBBERS AND ELECTRICAL CONTRACTORS.[1]

BY FREDERICK BISSELL.

Co-operation, much to be desired, certainly possible and the aim of all men who are thinking earnestly, outlined by your own resolution which says that the natural course of merchandise is from manufacturer to jobber, then to the contractor, central station and others, and then to the consumer. And to this policy are committed both the jobbers' and contractors' association and everything possible is being done toward this end.

That it is advantageous to the contractor to buy from the jobber is an old statement and grows stronger every day. The time worn story that the jobber does concentrate merchandise, making a depot from which the contractor can draw assorted items on demand, that he makes a few shipments of many items, that he can always offer good railway facilities because jobbers are found only at points having such facilities, that the contractor needs no large investment in merchandise and can devote his capital to other necessities in his business and that he can and does on occasion receive financial favors—all these things are true and are better understood every day.

We recognize that there are advocates of other policies who disagree from this but with the changes constantly making in all parts of the business world, and which are very active in the electrical field, it is certain that the jobber who fits himself to properly handle the contractors' business and who treats the contractor justly will always have his own reward.

That many things are now in the wrong and that we are far from the ideal is obvious, yet we believe that the trend of opinion and of events is in the right direction. The thing to do is to get together, but it is much easier to outline the present defects and the future perfections than it is to tell how to avoid one and to reach the other.

One of the first troubles is found in the jobber who does a construction business or runs a construction department and for a reason in which he is sincere and which is generally based on some local condition. This method is not approved by jobbers in general.

Then there are contractors who attempt a jobbing business, and for reasons equally sincere and to them equally satisfactory yet who retain their construction business. Both of these men are detriments to their respective associations and have been the causes of the most serious obstacles in the working out of this problem. If such a jobber be asked to cease construction or the sale of merchandise to isolated plants, he points to the contractor who is striving to retain his construction business and yet get into the jobbers field. And to make his argument entirely sound from his side he will attempt to prove that the contractor is always the one who is trying to buy direct from the manufacturer and to cut out the jobber. This same contractor brought on the carpet for his sins, points to the jobber who still retains a construction department and because the pot and the kettle are both black they soil everything in reach.

[1]Paper read before the Toledo Convention of the National Electrical Contractors' Association, July 22, 1909.

The contractor points with disgust at the curbstone operator with the proverbial screw-driver and coil of annunciator wire and is unable to appreciate how the little fellow can get stuff at the big contractor's prices. Yet he fights vigorously and some times viciously against a quantity price, himself endeavoring to buy one at the price of one hundred, has plenty of reasons why an initial price with rebates for quantities purchased in a given time is all wrong, and in other ways obstructs plans which, possibly imperfect, yet have the merits of being honestly designed for the protection of the big buyer without forgetting justice to his little brother. There is not a man in either association who was not once small and who was entitled to and had his chance and the right to prosper, if he showed ability and nothing short of that is thought of today. Nor will the economics of business, regardless of legal objections, ever permit anything different. The price for quantity always has made a difference and doubtless always will but what can be urged further than that, what distinctions may be made to conform to divisions of business, no one is prepared to say.

We repeat that the contractor who avoids the jobber, and the contractor who tries to become a jobber and a contractor at the same time—and the jobber who does contracting—are alike equally guilty of being obstacles in the road of co-operation. Too many irons in the fire is bad practice and few can keep more than one hot at a time. If many irons be possible what is to prevent the growth of an octopus who will manufacture, job, retail and construct all over the country with branches in all important points, big and little? What is to prevent this octopus from incidentally absorbing the central stations too with departments for installing door bells? Are we drifting that way?

Suppose the contractor has a scheme to eliminate the jobber and is successful. The jobber promptly retaliates, engages in construction and the latter case is worse than the first. Trouble from this source is already on us and, in some localities, the line of demarcation between jobber and contractor is very dim. All results are warnings in favor of better co-operation.

Along this line of investigation it may be well to ask if the jobber is really a business necessity. No doubt exists in the minds of the jobbers themselves, although there have been some manufacturers and some contractors unkind enough or misguided enough to regard the jobber as not an absolutely essential member of society. For those who entertain such ideas it may be well to remind them that no one who is useless endures. The progress of events takes him out. Yet from the earliest history merchants who bought in bulk and sold in broken lots have been prominent and doubtless always were dominant in the business world as they are to-day.

Some things do today go from manufacturer to consumer, but not very many. Judged from everything the jobber is here to stay because he is a truly useful member of business economy, and when he ceases to be useful he will vanish. It may be helpful to appreciate that vanishing is not a monopoly.

This same question of being a business necessity may with equal propriety, and possibly with more justice, be put to the contractor to ask him his reason for being on earth, and the answers are alike—that too many irons in the fire is bad practice, and that each division of business needs its operators, and that contracting is a necessary business division.

Once more to review, it is true that if the contractor's goal is to be the construction business, he needs the jobber; but if he aims to be a jobber himself, he needs the manufacturer. Then when everyone becomes a jobber, what happens?

What is to decide a contractor in his plan? Where does he look for an example? The relations between the manufacturers and the jobbers are not perfect, but that is another story. It is, however, as good as the relations between the jobber and contractor, but the relations between manufacturer and contractor are certainly bad enough to excite the condemnation of every thoughtful man. And right here we put our finger on the source of many of the reasons why the despised curbstone operator does not stay where you say he belongs.

Again, the contractor argues forcibly that he deserves a percentage on his material, which all jobbers cheerfully admit and endeavor to provide, but is it equally true that all contractors admit that the jobber is entitled to his percentage? No one expects to lessen the energies of an active buyer. Yet it does seem that when a man buys as low as any one in his class, be he jobber or contractor, that he should be satisfied and then endeavor to make a profit on what he has bought. That this delightful condition does not exist we know only too well.

One betterment which is coming rapidly is in improved internal business methods. Both jobber and contractor are keenly alive to these. The better methods include buying with regard to the profit which can be made when the goods are sold; better bookkeeping, collecting and paying; fewer open accounts either way; selling goods and doing work only when a profit can be made; and along these lines success is certain.

Lately much attention has been given to just these things in the grocery trade, a business where the retail condition for years has been unsatisfactory, where the manufacturer has insisted that by liberal advertising he could create a market and compel the retailer to handle his cereal, or tobacco, or whatever it might be. And now we see a movement started in St. Louis where members agree to sell only such goods as pay them (the retailers) a profit.

The store counter trade in the electrical business is happily in no such straits as this and is a feature to which much attention can be given. The same methods which are successful in other lines apply directly here, and, if it is true that the cigar business will justify the lease of a skyscraper just to get control of the corner store on the street level, it is certain that something in a retail way can be done in the electrical business.

This requires a selling organization consisting largely in promptly answering the telephone, keeping the store new and bright, reasonably good window and counter displays, cleanliness of store, proprietor and clerks, knowledge of the business, unfailing courtesy and reasonable advertising.

Our company has asked each of our salesmen to read the article on the cigar stores which appeared in the Saturday Evening Post of July 10th, in which all this is put out in excellent detail and is well worth the time of any man who does any retail business.

Perhaps the greatest enemy to the contractor's success, particularly if he is a retailer, is the unwise attitude adopted by some central stations in giving away articles which consume current. For this there is no reasonable defense. Many manufacturers protest against this with varying vigor, but some absolutely prohibit the slaughter of their articles which are controlled by patents.

To one central station who offered to do big things for one manufacturer and who was entirely earnest and well able to carry out his suggestion, the manufacturer argued that instead of killing the article, why did not the central station take it out of the price of the current, which to him seemed the reasonable way to promote the current business. This was refused. Yet we all know that it is the right way to increase consumption of juice, as witness the power companies supplying current to big mills and factories. The consumer is waking up to the fact that he is the victim—that the present of a flat iron on a high rate is loaded and sure to explode and take a few of his fingers along with it.

Yet the central stations have some proportion of reason when they say that they are forced to do these things because contractors do not run retail stores, do not promptly take up with new ideas, some times attach too high a percentage of profit and thus kill the introduction of new devices, and other arguments with which you are familiar. The question for us is, are these arguments sound? If they are we must permit the central stations to go ahead on almost any lines they choose, for we neglect the business and they have a right to it. If, however, we can show them that the sale of current consumers is actively solicited in their city by one or five or fifty contractors, and that collectively much more is done than the central stations could accomplish with its own corps of salesmen, then we at least have the opportunity to prove to the central station that such methods are neither necessary nor profitable to them. This situation for the contractor and central station parallels that of the jobber with the manufacturer who goes direct to the consumer or to the contractor. Both methods will cease when they are no longer necessary. It is what men do, more than what resolutions they make, which determines business methods.

Now, what is the general situation? Must we all continue until the electric business looks like the market for patent medicines, where the jobbers pay 60 cents for a bottle which retails for $1.00, yet the consumer can buy it from the department store for 58 cents. If so, what is the use? But we have unbounded faith that this is not so; that not only the nature of this business, but the class of men in it, will find ways to make money proportionate to the investment and the efforts which are now in it, and that these are great is well recognized.

A manufacturer cannot be a jobber nor a contractor nor a retailer unless he assumes all the responsibilities, risks and expenses which go with those divisions of business, and when he does assume them the exclusive jobber and the exclusive contractor can always beat him. And we have the further advantage of the effort and experience in other lines, like the grocery trade referred to; their troubles extending, as do ours, straight back through the jobbers and the manufacturers. The Woolson Spice Company disapprove entirely of those jobbers who roast their own coffees and grind their own spices, and they have other troublesome questions, as we do. Truly, we are not alone and the experience of others will at least be helpful, if it does not show us the way clear out.

That there is a way to arrange these things to the mutual advantage of all concerned, and that the way will be found, is a certainty. Just how, we do not know, although we are here to welcome and adopt any feasible plan, even if it is only one step in the right direction. Perhaps these betterments will first come locally and later will be universal.

Who will take the initiative, or who can take it? We must start somewhere. Who will clean house, learn what can be done and be the first to do it? It is not only a question of who will, but also who can.

To go back to the beginning of this talk, it is easy to see the many advantages for us all. Those who have really thought on this subject recognize that it must be mutual. But when we attempt to reach this promised land we find as many obstacles as Moses did. The solution will come along economic lines and will eventually take care of itself by the survival of the fittest, which is not saying that the contractors shall devour the jobbers; or contrarywise. It does say that each will find his proper place much quicker through co-operation than through strife; that we are made for each other, and instead of many offensive alliances with others, we should have one defensive alliance for our mutual benefit.

Meanwhile, the man who goes with his times, who is able and active and earnest, and who endures, can and will make money in the business of electrical construction.

Advertisements in telephone directories roused the ire of business men of Fond du Lac, Wisconsin, who appealed to the Wisconsin Railroad Commission to compel the Wisconsin Telephone Company to furnish directories free from advertisements. This was on the ground that advertisements of foreign and local firms hurt the business of the petitioners. The Commission wisely refused to interfere in the matter and further decided that, "any act, practice or collateral, undertaking of a public utility company, not affecting prejudicially the reasonable performance of its duties and obligations to the public and individuals, although displeasing to some of its patrons because tending to prejudice in respect to their private interests, is not within the scope of the regulative powers conferred upon the commission, that the universal practice of telephone companies of using their directories as advertising mediums is a practice collateral to the public functions of such companies; and as long as not interfering with the discharge of such functions, is not within the regulatory powers of the commission; that the respondent furnishes adequate directories to the petitioners and to the public and the use of the same as for advertising purposes does not impair its serviceableness to the public."

UNDERGROUND ELECTRIC CONSTRUCTION.

Discussion by members of the San Francisco Section of the A. I. E. E., December 17, 1909, of paper read by S. J. Lisberger and published in this Journal, October 9, 1909. The following participated in the discussion:

George R. Murphy, sales engineer, Pierson-Roeding & Co., San Francisco, Chairman.

L. E. Reynolds, Oakland, Cal.

A. J. Pahl, foreman, underground department, City Electric Co., San Francisco.

Geo. C. Holberton, engineer, electric distribution, Pacific Gas & Electric Co., San Francisco.

C. J. Wilson, superintendent, electric department, Oakland Gas, Light & Heat Co., Oakland.

S. G. McMeen, engineer, Home Telephone Company, San Francisco.

C. L. Cory, professor of electrical engineering, University of California, Berkeley.

L. R. Jorgensen, designing engineer, F. G. Baum & Co., San Francisco.

S. J. Lisberger, engineer, electric distribution, Pacific Gas & Electric Co., San Francisco.

H. Y. Hall Jr., assistant electrical engineer, Southern Pacific Co., San Francisco.

A. H. Babcock, electrical engineer, Southern Pacific Co., San Francisco.

H. W. Mozier, superintendent, steam plant, Oakland Gas, Light & Heat Co., Oakland.

H. L. Worthington, general foreman electrical distribution, department, San Francisco Gas & Electric Co.

L. E. Reynolds: I was interested in the first installation of the "Independent" system in San Francisco, and I wish we could have ideal manholes as Mr. Lisberger has shown tonight. There are a good many places where the streets will not permit of them, because of pipes and other obstructions, but time will work out these and other problems, and I admire the paper as a very good description of an underground system. I would like to have Mr. Lisberger tell us more in detail of the high tension apparatus, or possibly Mr. Pahl could let us know what is being done in the City Electric system, exemplifying the same in a slightly different way. I would like to hear about some of the troubles they have had under their conditions of operation.

A. J. Pahl: The City Electric Company uses 3-phase, 4-wire 11,000-volt grounded neutral system of distribution for both overhead and underground. The system consists of a network of lines and cables which are separated by switches, and each section controlled by a feeder. These are arranged so that any section or feeder can be cut out and still keep the balance of the system alive.

In the underground districts 3-phase cables are run. These are divided into sections by special water-proof 3-phase oil switches. At the intersection of the side streets off Market street taps are brought out of the main cable, and that street is fed single-phase at 6400 volts. Alternate taps are brought out of this cable.

On the main side streets single-phase cables are run direct from the sub-station. There is a sub-station in the downtown district for generating direct current for elevator and power service. The sub-station is also a switching station for the downtown feeders. With this voltage no transformer sub-stations are required, and the entire city can be fed direct from the power house.

One of the main features of the system is the oil fuse and switch. This consists of a cast iron box about 9 in. x 9 in. by about 20 in. long. It is filled about two-thirds full of oil so as to allow plenty of air space for expansion. The cables are brought into the box through special porcelain bushings under the oil, and wiped to hose nipples on the outside.

The fuse arm is controlled by a shaft through a stuffing box on the end of the box. The fuse arm can be raised clear of the box so that it can be operated without danger to the operator. This box is used both as a fuse and switch to control branch lines as well as transformers. These fuses have operated under short circuits, and no damage was caused.

The system has been in operation about two years, and there has been no trouble with operating at this voltage. There have been but two cases of primary cable failures, and these were due to poor workmanship on the part of the splicer.

The operating is more simple than with the 2200 volt system. There is only one hot leg to be taken care of, and the workman never works on a live part. Enough section switches are installed so that any section can be cut out and fed on the secondaries during the day time.

The primary drop is very small, and by proper distribution of the transformers very good regulation is obtained. Besides the flexibility of the system it is very economical in the use of copper, and the best results have been obtained.

Geo. C. Holberton: It is a little unkind of Mr. Reynolds to talk about the troubles of the City Electric so soon. We, however, have had lots of trouble, as Mr. Reynolds knows better than I do, because we have been in operation a great many more years. After the fire we certainly had a very serious condition of overloads on various cables, due to the fact that in a few days the entire condition of the load changed, that is to say, where we were provided with plenty of cable capacity and were able to take care of the business we had no business; where we did not have the cables we had lots of business, and we certainly sat up nights and tried our best to keep things going. However, that condition has now been rectified, and we have a system of distribution which meets with Mr. Reynolds' idea of ideal manholes. Mr. Worthington (who is here) has been working several years gradually cleaning up and putting the manholes into this ideal condition, and we find it certainly pays. Our manholes now have all been cleaned up, all surplus material and unnecessary boxes (if there were any) removed, and the whole system simplified as much as possible.

In reference to the Edison tube that Mr. Lisberger spoke about I think that that has been abandoned practically everywhere. We still have a good many miles of tubes, but we know that it is in bad shape and must in a very short time be taken out. That is due largely to electrolysis and local chemical action which has eaten off the metallic container, so that that coupled with the overloads that the Edison feeders have had to carry, means that it must ultimately be replaced by some form of draw-in system.

Going back to the paper as presented, there are some points that I would like to bring out. For instance, if any of you should go up against underground ordinances as drawn up by the cities, it is well to bear in mind the following: In the first place the former method was to create an underground district, and state that the wires must be placed underground within a certain time. This is, from the company's standpoint, the wrong way to look at it; and the proper way to word this ordinance is to state that the poles and wires must be removed from the street in that district. That gives you a chance to avoid in many cases the installation of an expensive underground district. At the present time the sentiment against the overhead wire is very strong, and the matter has been carried to an extreme, and underground districts have been created where you cannot lay out an intelligent underground system, due to the fact that the existing buildings are of a temporary nature, and you cannot see far enough ahead to know how you are going to get the load; and in that case you can often feed into the buildings from the side streets, and in that way avoid entirely the necessity for an expensive and permanent underground structure, and that is really better, not only from the company's standpoint but from the city's standpoint. If an underground system such as Mr. Lisberger has described were to be installed in some of the underground districts today it would not

be more than two or three years that you would have to abandon some of it, and add to the others, which means tearing up the streets, and is certainly objectionable. To illustrate, in San Francisco, for instance there are sections of Fillmore street consisting entirely of wooden buildings of a temporary character, and which will undoubtedly be abandoned. In these districts we have been able to remove the poles and wires without the necessity of going to the expense of putting in an underground system and tearing up a street which has not been improved for more than eight or nine months. This has been done in a manner similar to that described by Mr. Lisberger, when he spoke of leading wires from the manhole up the face of the building. Instead of that we merely bring the iron conduits around the corner of the building to the side street. As that work is now done in a substantial manner with either condulets for outlets, it is a great deal safer than some of the work which is permitted in underground districts, and the methods which we used have been inspected by the department of electricity, and approved.

C. J. Wilson: Mr. Lisberger did not mention the protecting of the cables by the use of asbestos tape, which is wrapped around the cable sheath and then cemented with some silicate solution, which hardens very quickly and makes a very good protection to the cable, and also protects any of the adjacent cables in the case of a burn-out.

We have just completed a district in Oakland where we were directed by a city ordinance to remove the poles from the streets, and I think everybody interested in Oakland will see that it is quite an improvement.

S. G. McMeen: Mr. Lisberger's paper has such a practical nature that it is of great interest to all of us who have to do with conduit systems. There are certain striking differences between such a system as he has described, and one which serves purposes of electrical communication. Perhaps the most marked difference is that in the communication systems as ordinarily designed, there are fewer kinds of things in the manholes. In a modern telephone system, for instance, in other than the most congested centers, distributing terminals, protective apparatus and translating devices are not found in manholes. Such a manhole usually contains cables and splices only.

Mr. Lisberger speaks of the difference between brick and concrete manholes being principally one of strength and watertightness. On the Pacific Coast there is a further important difference; that of cost. If one considers the cost of the quality of brick best suited for a manhole, he will find that on the Pacific Coast the cost of the brick alone is about as great as the completed concrete manhole, not counting cover and frame. The cost of the cover and frame in position is about the same for other construction. One of the usual advantages of the concrete manhole, in that it can be made in a standard form, is not as adaptable to city conditions as might be wished. In downtown San Francisco, for example, the size and form of a vault is controlled so much by what is found in the street that the use of standard forms for concrete pouring is the exception rather than the rule.

As the accessibility of the various forms of splices in the vault of a telephone system is a matter of great importance, it is found an advantage to limit the maximum width of the conduit lines to four ducts. With this construction the four cables entering a vault in a layer may be divided into two pairs, and the cables carried around the sides of the vaults only two wide on a side. Under proper conditions, limiting the width of the conduit line to four ducts makes no substantial increase in its cost as compared with greater widths.

The method of supporting cables in vaults, as described by Mr. Lisberger, involves placing the sleeves for the cable-supporting pins at the time the concrete is poured. In some circumstances this may not be done, the sleeve for the cable-supporting pin being placed in a hole drilled afterward. We have lately had occasion to drill many thousand such holes, and have found most useful a compressed air drilling outfit. This consists of a gasoline engine and an air compressor, with air, water and fuel tanks, all mounted on a proper truck. The cost of drilling holes for cable supports with such a pneumatic drill is so low as to compare favorably with the cost of placing the sleeves at the time the vault is poured.

G. C. Holberton: The practice here is to make the ducts as tight as we can, but all the ducts have a slight grade to drain the water to the manholes. Our standard grade is 4 inches in 100 feet. That is about the grade we give the ducts. I regret very much that Mr. Lisberger has shown a picture of a very improperly constructed trench in that he shows bridges. The ditch should be opened up clear through, and no bridges allowed. You never can fill a ditch with bridges as well as a ditch that is open from manhole to manhole.

C. L. Cory: I could not help thinking this evening, while Mr. Lisberger was reading his paper, of an article I read a good many years ago about the difference between the light of the tallow candle, where the generating station at the place of consumption occupied a space of one cubic inch, and the present systems of illumination, where the generating station may be a great many miles away, and the innumerable points of consumption are a very great distance from the source of power. When one thinks of the number of links between the central station where the electricity is produced, and the different consumers, the problem of maintaining continuous service must impress itself upon us.

I suppose there are a number of us here this evening that can remember the time when all of our interests were concentrated in the generating station, and almost confined to the device which was used to produce the electric energy, its efficiency regulation and so on; but as we know now, the generator is but a small part, and it is by the development of the art, the changing from the old overhead work to the underground construction, and the introduction of the most efficient means of utilizing the electricity, that we begin to attain the highest over all efficiency.

Mr. Lisberger mentioned this evening one thing which is quite true—the difference in simplicity between the distribution of direct current and alternating current. And yet, when we think of the extent of alternating current distribution—we heard this evening of one at 11,000 volts, 6400 volts between conductors and earth—the transformations of voltage, and the many uses to which the current is put at different voltages—we must admit that the alternating current system of distribution with transformers is most satisfactory.

There is one thing I could not but be interested in this evening. It happens that it has fallen to my lot at times to represent municipalities in which certain ducts were to be set aside for the use of the city; and it was assumed that the employees of the city might work in the manholes installed and used principally by public service corporations. I don't know that my attitude of mind would be appreciated by those who have to do with the building of these manholes for the corporations; but it always seemed to me that the manhole in connection with underground construction should be just about as sacred as a bank vault and that nobody should go in there and do work unless it be under the supervision of the man who was responsible perhaps for its design and construction and continuous operation.

Just one other word regarding underground systems replacing older overhead systems. As Mr. Holberton and Mr. Wilson perhaps remember, I have been called upon to look over certain installations or certain services where almost without any warning it has been necessary for the power company to transfer the service from overhead to underground; and while Mr. Lisberger has given us a very complete explanation of the ideal manhole, as Mr. Reynolds might put it, and the construction of an underground system, yet even after that is done, it is really of a somewhat important character and a difficult accomplishment to change the service from the old overhead service to the underground, and yet get the sort of installation which shall be satisfactory in every particular; and I am quite in agreement with Mr. Holberton that in many instances the requirement

of the community, whether it be by the supervisors or the councilmen, is one almost impossible of accomplishment; and I think that engineers in general should bear this in mind. We cannot help but remember that the business of the serving company is to deliver to the consumer that which is required, whether it be telephone or telegraph service or electric light or power service; and as far as the customer is concerned, often he is not willing to give the serving company credit for the difficulty which may be encountered in giving service. And so it is I think that many times we are inclined to feel that these almost sweeping changes are demanded so quickly as to make it almost impossible for the company to do the work as it ought be done. The idea of taking a certain district, and saying it shall all go underground, as Mr. Holberton said, is a very different thing from saying that the poles must come off a certain street. Whenever engineers have anything to do with such matter we should bear in mind that there is often other methods which may be used besides putting everything underground.

L. R. Jorgensen: Mr. Lisberger has covered his subject quite completely, and deserves much credit for having given out the accumulated experience gained by doing underground conduit work on a large scale. I think we can all appreciate what a big corporation is up against when the city compels it to put its wires underground in ducts, as these ducts are often as costly as the wires themselves. The city supervisors in many places have the idea that it does not look good to have the wires up in air (laughter); they think people should be able to see the sky, even when walking on Fillmore street. (Laughter).

Incidentally there are several other advantages in putting the wires underground, even if it is costly. If done in the way Mr. Lisberger has described, it is permanent construction so far as the ducts and manholes are concerned. The cables of course are not altogether out of danger from burnouts, grounds, etc., although they are pretty well protected in the ducts, and faults should not be as difficult to detect and to repair as with the Edison tube system, which system perhaps is cheaper to install but more expensive to maintain, especially where the outside pipe is subject to the action of electrolysis. What the proper depreciation charge for the Edison tube system will be Mr. Lisberger has not told us. I should think between 5 and 8 per cent. I do not figure depreciation in exactly the same way as the speaker at a recent institute meeting here. If you put your pipes in the ground 40 years ago and you go and look at them today, you will hardly be able to see them for dust, even if the cost of construction was a million dollars. (Laughter).

The clay duct system is the most substantial, and outside the cables there is not much that can depreciate, and if a bare copper wire is run alongside of the cables, and the lead cover tied to this wire at intervals, in the manholes for instance, there is not much chance for electrolysis eating through the lead cover. It is understood that one end of the bare copper wire should be tied to the railway return circuit causing the trouble as near to the railway power station as possible.

As to the system of wiring we have seen that the service mains run in the same line of ducts as the feeders, and that the service connections from the mains are made either from the manholes or from handholes located at convenient places between the manholes. The size of the feeders is easily determined after the load is estimated or calculated and the drop fixed for example at 10 per cent. The size of the distributing mains are more difficult to determine, as these are fed from both ends and current taken off at different places throughout their length. The amount of current flowing from each end is found in the same way as the reactions of a loaded beam supported at both ends. Then the point in the main where the currents from both ends meet is easily determined, and this is the point of maximum drop, which drop should not exceed 2 per cent in lighting circuits. This condition determines the size of the distributing main.

K. G. Dunn: I think it would be interesting if Mr. Lisberger would tell us how he located grounds in the system—if you have new stunts on that for quickly locating them?

S. J. Lisberger: If you have a real good short you don't have much trouble. Usually we use in San Francisco a little device that we call a jigger.

After having located the leg of the feeder that is grounded (which can usually be done by means of a small transformer, one terminal of the primary of which is connected to one of the three buses or one of the three legs; the other terminal being grounded) the lamp is connected in series with the secondary The lamp will light when the transformer terminal is placed upon the leg that is grounded.

We next impose a high frequency current on the grounded leg by connecting one terminal of a small motor generator to same, and the other terminal to the ground; and then by means of a telephone receiver, which is carried along and held over the manhole, from the sound induced in this receiver by this high frequency current we can locate the fault. The receiver will hum quite distinctly if same is held over the manhole between the point of the fault and where this high frequency current is impressed, (which is usually at the station) but when beyond the fault, the receiver will not hum.

H. Y. Hall Jr.: Have you looked into the scheme they use at the Seventy-fourth Street Power Station of the Interborough Rapid Transit Company, New York? They, have a 100 light Brush arc machine which has a reverser, which reverses the direction of the current in the line about once every four seconds. The machine is used as follows: In cases of a grounded phase, they connect one side of the arc light machine to the lead sheath and the other side to the grounded conductor. In cases of short circuited phases, the terminals of the bad phase are connected to the arc light machine terminals. Whenever a ground or a short circuit has too high resistance to allow the arc machine to build up, a high tension testing transformer is used to break down the cable. The current flowing, goes out the conductor and back through the lead sheathing, and vice versa, reversing every four seconds. The cable men go out to the different man holes, and place a compass on top of the cable, and every time the current reverses, of course, the compass swings around 180 degrees. When they get beyond the ground or the short circuit, the compass will not reverse.

S. J. Lisberger: That is very much on the principle of this little jigger, except that you have to open the manhole.

A. H. Babcock: I haven't had much to do with underground systems except in Salt Lake City, where the city authorities required a certain proportion of the work to be put underground in a given time. I believe we ran over our time about 100 per cent or more. The city blocks there are very large. If I remember correctly they are between 600 and 700 feet square. The problem there of course is a little different from what it is in San Francisco. So much waste space exists in the center of the block that it was easy for us to get sub-station locations in the block center; to come underground there at 4000 volt circuit; to place the transformers on the surface of the ground instead of in the manholes (which is a distinct advantage) and run out from this little station at ordinary working potential, 3-wire single phase, also with the 3-phase motor circuit. In this underground work he followed practically the same construction that Mr. Lisberger has outlined here.

From time to time I have noticed in the technical press notices of a different form of construction, in that a fibre conduit was used surrounded by concrete, the tubes being six or eight feet long, with screw connections. I would like to ask if anybody has had any experience with such system for underground work for lighting service, and what the practical results are in regard to breakdowns?

H. W. Mozier: I believe that this paper tube that Mr. Lisberger spoke about is the fibre tube.

S. J. Lisberger: There are two kinds: the paper was the first development, and the fibre the next. I don't remember whether that one that went up was paper or fibre, but I know what happened; the street went up with it. The thing was that the duct clogged so we could not shove anything through it. We could only get our fish wire in so far, as far as where the burn-out was. We located where it was by measuring and digging it up.

A. H. Babcock: What was the condition of the duct?

S. J. Lisberger: It was fused and clogged.

G. C. Holberton: We laid some in Oakland on Second street, tried it as a matter of experiment. Based on the price they would charge per lineal foot we thought it would be very much cheaper, due to the fact that it was light, easy to transport, and in laying it a man laid a great many more duct feet at one time than with the clay duct. In practice, after having laid about two blocks we found that the cost was just about as great as it was with the clay duct, and did not offer any material advantage. I think that the ideal system, as far as high tension cables go, is to lay single ducts with all joints staggered. That for high voltages this is ideal. I have never known a cable in giving way to melt such a duct.

S. G. McMeen: Do you use any split single duct, where you want to pick up and replace a damaged section of a cable?

S. J. Lisberger: I don't recall that we have used any of that.

S. G. McMeen: Mr. Holberton states that a single duct offers that advantage, that you take out the single duct because it is split lengthwise.

G. C. Holberton: We try and keep our outside ducts free, and very often use the outside ducts without building a service hole, by breaking into them as you describe. In which case we open up the street and expose one of the outside ducts, and pull the cable into the consumer's premises directly from the duct.

S. J. Lisberger: I found a peculiar condition in Newark. split form in power house work after the cable is up to get protection against short circuits. It gives you one solid wall. The Chicago-Edison used a good deal in their sub-station work.

S. G. McMeen: They had a number of cases where they had to have some such solution, and they continued to use it extensively.

H. N. Mozier: In New Jersey and surrounding towns one company with 13,200 at their primaries, in recent years have put in almost all fibre ducts. They formerly put in paper duct. The telephone office there found the use of the fibre duct costly. They abandoned it to use clay entirely, because of the difficulty in pulling out the cables.

S. J. Lisbeerger: I found a peculiar condition in Newark. Practically all of their secondary cables, that is, cables of 200 volts, were rubber insulated without lead in their underground system.

A. H. Babcock: I always understood one of the strong points of the Orangeburg fibre duct to be that when there was a burn-out it would not be damaged. I am surprised to hear Mr. Lisberger state that there was trouble where he had to dig the street out.

The Chairman: The public service corporation of New Jersey is using fibre conduit entirely in their lines across what is known as the Hackensack meadows, a very marshy and wet section about eight miles wide. The New York & New Jersey Telephone Co. is also using fibre conduit for all lateral lines.

Fibre conduit is used exclusively by the Brooklyn Edison Co. for their underground system. I know that the experience of the Brooklyn Edison Co. is that they haven't had as much trouble from burn-outs, with fibre as others have with tile. Perhaps Mr. Worthington can help us out on this?

H. L. Worthington: I would like to state we had a little experience a few nights ago at the junction of Post and Kearny streets. The Pacific Telephone Company had laid a paper duct up and down Post, and whoever had charge of the laying of that paper duct forgot to put concrete around it, especially between the paper duct and the Edison tubes. Our Edison tube ran north and south on Kearny, and the paper duct east and west on Post. There was concrete all around the paper duct except between the iron covering of the Edison tube and the paper duct itself. A short circuit came in on the Edison tube, and the copper in the paper tube started burning. The consequence was that three of the telephone company's manholes exploded, and the police department and the fire department were called out, and for a while there was all the trouble you wanted. The only damage we had was the loss of about three feet of the Edison tube. I don't know what the extent of the damage to the telephone company was, but I know they had a big crew of men working for 48 hours or more. It happened at a very bad time because I understand that the main cable of the Pacific Telephone Company running to the Palace Hotel was the one that burned up. Colonel Kirkpatrick was afraid he would have no telephone service on the night of the banquet, but they worked overtime and got it working.

Speaking of ideal manholes for electric light and power service, I wish to state that we have some manholes in the city at the present time that I consider ideal. We have manholes here that are so equipped at the present time that it is no trouble at all to operate hot at 2300 volts. With the wooden fuse tongs and other appliances that we have it would almost be safe for a layman to go down and operate the boxes, even a man not familiar with the business.

Speaking of underground ordinances and overhead lines removed and one thing and another, I wish to state that a week ago yesterday I received instructions to remove all poles and overhead lines on Fillmore street between Sutter and Fulton, the same to be removed and wiped out of existence by January 1st. In that territory we are, I think, at the present time delivering somewhere between three and four thousand kilowatts. That was quite a problem. It is a territory that covers, from Sutter to Fulton, a business thoroughfare, and when it comes to working on the overhead end of it the linemen are handicapped by the number of people promenading up and down the street, especially the women looking in at the show windows. The problem that we have to face is to supply all these establishments with light and power and at the same time simply wipe your line out of existence. As Mr. Holberton said a few minutes ago, one ordinance passed by the Supervisors here pertaining to Fillmore street reads that the overhead poles and wires must be removed; and I would like to mention that it would be quite an interesting proposition for any member here tonight to go up to Fillmore street and notice the class of work we are doing there. It is a new style of underground work, which requires no ditch in the street. We take our conduit, and run right along the face of the building, and it makes a very nice neat job, (laughter). I may say, as far as the underground part is concerned, as Mr. Lisberger said this evening, the character of the buildings on Fillmore street is such that it would be impossible for any engineer to figure out an underground system in that territory. Most of the buildings are of a temporary character, and if you go ahead and put in an underground system in two or three months you should have to change it. With the conduit system we are putting in there at the present time it is ideal, and I think it would be worth while for any member here tonight to travel out that way and look at it.

Question: How do you cross the intersections between streets?

H. L. Worthington: We are feeding the different blocks from the cross streets. The ordinance does not prohibit us from continuing the pole lines on the cross street, across Fillmore, but we are not allowed to maintain any lines on Fillmore.

G. C. Holberton: I would like to state that there is another form of underground conduit that you have not mentioned at all. I don't know very much about it except what I obtained in the way of literature, but a firm in St. Louis has a patented scheme for constructing underground conduits very much as

you make maccaroni. They have a concrete mixture which they pull along the ditch, and after they pass by you have one of those peculiar underground systems with as many holes as you want. I think there is probably something in it.

A Member: There has been some thousands of feet of that put in in one of the smaller cities near New York. It is worked in quite a simple manner. They used paper tube, and they elevate a tank about 15 feet high on legs in the street, and connect all these paper tubes with the water, just about enough head to keep the concrete from collapsing the tube, and they have a form which they drag along in the trench, and the concrete is poured into this form, and the tubes are carried right through the form, and the water keeps them swelled out to the proper size to form the duct.

They have another variation of this. Instead of using concrete, they use concrete made with an asphaltum plaster mixture; and they have tried some of that to a certain extent, and by using bare copper conductors they have been able to use 220 volts with no conductors at all. How long they will last against water and other things is another matter.

S. G. McMeen: Relative to forms of duct material, a good example of a moulded duct is found in Mexico City, made of concrete in multiples. The length of a section is one meter, and the number of ducts per section as high as 36. The sections are poured in a metal mould in a yard near the work, and are laid with proper alignment directly in the ditch without a special bed or an envelope of any kind.

Where the costs of cement and labor both are low, as is true in many of the southern countries, and where standard duct materials would have to be brought from a distant market, such a method has distinct advantages.

A Member: I would like to ask Mr. Lisberger if the effects of electrolysis on the Edison tube have been very wide-spread, and in what localities found?

S. J. Lisberger: The subject of electrolysis is very broad. It has no different effect than on a gas-pipe, except more localized in certain sections, due to the fact that where junctions come you don't get very good contact from pipe to pipe.

Question: That should help it out?

S. J. Lisberger: In a gas-pipe where it is leaded in you get good contact; therefore not so much electrolysis action on each section.

Question: I would like to ask if any solution has been offered whereby telephone and telegraph, light and power currents can all be put in one conduit system. I believe I have seen something in connection with that. A city had put in its ordinance that the company should provide a certain number of ducts for its private use. We do know that cities have compelled light and other companies to combine and do away with so many poles, and put the high tension lines at the top, and the telephone lines either on cables lower, and thus cut down the number of poles to one quarter of the number that originally existed. I believe Los Angeles has been boasting considerably of late years of that idea, where the poles are common property of the several different companies doing different classes of work; and I would like to know if this problem of using the different conduits has been worked out to make them a sort of common property for those different classes of service?

S. J. Lisberger: Baltimore has such a system. It was built by the city under the chief engineer, Phillips. They built a system and charged each company 5 cents per duct feet per year as rental. Boston I think in one or two places has such a system of that kind. New York has a conduit system but only in part—the Consolidated and Empire subways. They are now endeavoring to keep the high tension entirely separate. The disadvantage of the system is that if you have trouble you usually give it to your neighbor.

In going in one of the manholes in Baltimore in the crowded business section, which would compare with Third and Mission, with an 84 duct line, we went down something like 4 feet below the street before we got to the top of the manhole, and the manhole was about 12 feet deep. Of these 84 duct lines there were about 63 full. I had a good look and went up. I had no desire to stay in there. There were railroad load lines, 13,000 volt cable, ground return wires, telephone and telegraph. It was certainly a most dangerous looking construction.

G. C. Holberton: The usual practice here in the matter of the city obtaining the use of a duct line, is to work with the telephone companies. In the first place the general use of the duct line by the City is, that for their fire alarm and police department calls, which is more or less the same nature of service as the telephone company, in other words, communication. In the second place, they can do that for the reason that the telephone company operates under a franchise, and when the city grants the franchise it can put in that stipulation and the company can take it or leave it alone. In California the power companies do not operate under a franchise and they could not very well be put in under the same conditions. The right to lay the ducts and distribute is not a right granted by the city, it is given by the State constitution.

S. G. McMeen: There is no doubt that the practice here would be the usual practice, and which is dictated by common sense; that the high tension circuits could not properly go into conduits with the communication system. I think you will find, if an expression of opinion were taken generally in this meeting, it would be to separate the systems primarily on the basis of their use, the small wire, communication circuits on the one hand, and the large wire, heavy-current-carrying circuits on the other. If you ever went further than that, and combined large current devices and small current devices in one conduit line, every practical, thoughtful person would say that the two conduit lines must have separate manhole systems. If the worst came to the worst, and all the conduit lines in a given street were tied in one, unanimity of opinion would immediately be found that the power company have a separate set of manholes of its own. Such systems have been combined.

DEDICATION OF THURSTON MEMORIAL TABLET.

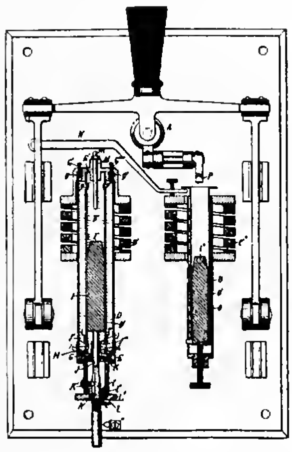
The New York monthly meeting of the American Society of Mechanical Engineers for February was devoted to the dedication of a bronze memorial tablet to Dr. Robert H. Thurston, the first president of the society. Addresses were given upon Dr. Thurston as a man, and his life work. These addresses touched upon his experience as an engineer of the navy during the Civil War; his work as an educator at Stevens Institute of Technology and at Cornell University; his achievements as engineer and investigator; as an author; and his long relationship with The American Society of Mechanical Engineers. Among those who participated were Prof. John E. Sweet, closely associated with Dr. Thurston in the organization of this society; Col. E. A. Stevens, the prominent represetnative of the Stevens family, founders of Stevens Institute; President J. G. Schurman of Cornell University; Prof. Albert W. Smith, Dr. Thurston's successor as director of Sibley College; and Mr. William Kent, consulting engineer. Dr. Alex. C. Humphreys, president of Stevens Institute, was the chairman.

INDUSTRIAL ENGINEERING—THE ENGINEERING DIGEST

The Engineering Digest has been consolidated with Industrial Engineering of Pittsburg and will hereafter be published as Industrial Engineering and The Engineering Digest by Robert Thurston Kent, formerly managing editor of Industrial Engineering. The publication offices are at 220 Broadway, New York City. In assuming charge Mr. Kent announces that at present only that it is his intention to continue the special features for which The Engineering Digest has been noted, including the valuable Index to current technical literature and the condensation of important articles and papers on engineering subjects. To these will be added special features along lines of industrial engineering, and original articles on engineering subjects, distinct from the civil and electrical engineering matters which are so well taken care of by other periodicals.

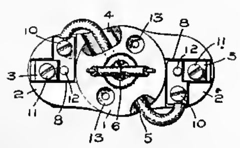
PATENTS

947,981. Electrical Time-Limit Switch. Philip K. Stern, New York, N. Y., assignor to General Electric Company.. The combination with an electric circuit, of a freely movable member for opening said circuit, actuating means for said responsive to predetermined current



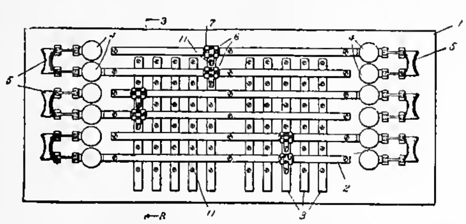
in said circuit and normally so related to said member that said actuating means is unable to move said member, and means responsive to other predetermined current conditions whereby the relative position of said actuating means and said member is varied to enable said actuating means to move the said member.

947,878. Fuseless Rosette. Herbert C. Wirt, Schenectady, N. Y., assignor to General Electric Company. A rosette for supporting knotted branch-wires comprising a single piece of ceramic insulating material provided with a



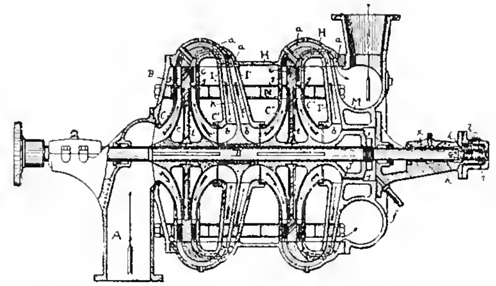
straight transverse aperture of sufficient size to receive said knot, with a central aperture connecting with the transverse aperture, and of a size to receive only the said branch wires, and with means for making contact between wires.

947,956. Metering Panel-Board. John J. Agutter, Seattle, Wash. A switchboard comprising a base, two series of conductors on said base spaced from and crossing one another,



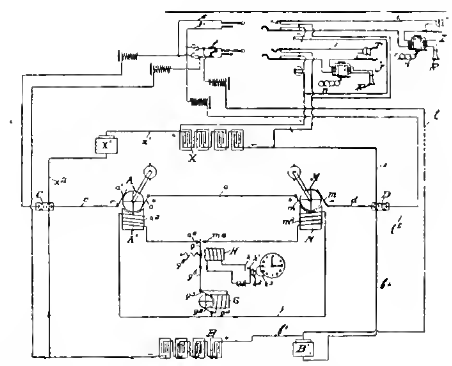
contact members slidably supported on the conductors of one series, other contact members carried by said first named contact member, and means on said other series of conductors for securing said last named contact members thereto.

948,292. Multistage Centrifugal Pump. Arthur Giesler, Dayton, Ohio, assignor to The Platt Iron Works Co., Dayton, Ohio. In a multi-stage centrifugal pump, two impellers ar-



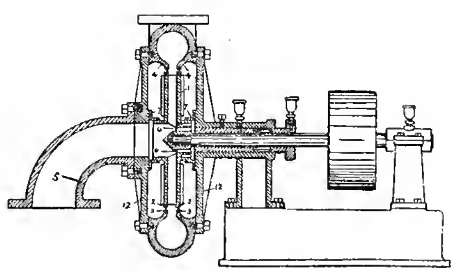
ranged with their inlets facing in opposite directions, passageways adapted to conduct the fluid from one impeller to the other, and means mounted at the intermediate inlet of the last impeller for balancing the thrust of the pump.

947,781. Apparatus for Alternating the Polarity of Current in Electric Circuits. Garrison Babcock, Rochester, N. Y., assignor to Telechrometer Co., Rochester, N. Y. An apparatus of the character described, comprising two generators



arranged in series and connected so as to be of opposite polarity and having fields, means for alternately exciting said fields, and means associated with two generators for absorbing the varying current of each polarity produced during the operation of one or the other of said generators.

948,228. Centrifugal Pump. Ferdinand W. Krogh, San Francisco, Cal. In a centrifugal pump, an impeller having protection on the discharge edge thereof, said protection consisting of a metal ring detachably secured to said discharge edge of the impeller, in combination with a stationary



casing having a circumferential rib on the inside of the same, and said rib having protection on its edge, said protection consisting of a metal ring detachably secured to the edge of the rib for the purpose specified.

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Fuel Oil Firing

The essential difference between steam power plant practice in the East and in the West is in the fuel employed. Coal, either anthracite or bituminous, is burned under the majority of the boilers in the East, while on the Pacific Coast crude oil is the most important fuel. In certain lumbering localities, particularly in the Northwest, sawdust is also used as a power source. The cause for this sectional preference is distinctly one of cost. Eastern coal is cheaper than eastern oil; western oil is cheaper than western coal. Cheap fuel is indispensable to industrial progress and it is only since the development of its abundant oil and water resources that the Pacific Coast has done much manufacturing.

Additive to its western cheapness and compensative for its eastern expensiveness there are certain advantages that attend the use of fuel oil. It burns without a residuum. There are consequently no clinkers and no ashes to obstruct the grate, interfere with the air supply and cause incomplete combustion. It is the most concentrated of fuels, occupying a minimum of space and giving a maximum of heat, weight for weight. It takes less time to get up steam with oil than with coal. This practically eliminates the necessity for banked fires or reserve in steam drums. Oil usually gives a larger overload capacity and is thus pre-eminently invaluable as an emergency fuel. Auxiliary oil firing is therefore frequently employed in plants burning lampblack or sawdust.

Oil is practically self-stoking and greatly lessens the work of the fireman, one man oftimes replacing several in a plant containing many boilers. This does not necessarily mean that the fireman's job thus becomes a sinecure, but rather it changes his work from that of a mere coal-passer, a machine, to that of an integral factor in the economic and efficient operation of the power plant.

By properly regulating the pressure and the amount of oil and by correctly adjusting the pressure and quantity of steam or air, the fireman can reduce the volume of oil necessary to generate a given amount of steam. In a single boiler plant, such as a locomotive, the fireman helps the engineer and thereby lessens the possibility of accidents.

To properly utilize the advantages above suggested, hundreds of oil burners have been devised, each better than the other. In general, they are all based upon a means of atomizing the oil and distributing it in the furnace either by compressed air or steam, theoretically the former, practically the latter. Crude oil does not burn readily until it has been subdivided into minute particles. It is possible to drop a lighted match into a tank filled with oil without burning the oil, but when each individual particle is properly mixed with air it is readily ignited. Experience shows that a burner which gives success with one type of boiler is not adapted for another. Proper furnace construction is of paramount importance with the type of burner with which it is equipped, and each class of boiler installation requires the special attention of an expert to give the best results.

PERSONALS.

C. H. Pennoyer, Pacific Coast manager of the National Conduit & Cable Company, is in Los Angeles.

Geo. R. Murphy, sales engineer with Pierson, Roeding & Co. of San Francisco, left for the East this week.

F. L. McGillan, manager of the California Pole & Piling Company, of San Francisco, recently returned from a trip through the Pacific Northwest.

G. J. Henry, Jr., engineer with the Pelton Water Wheel Company, is making a Northwestern trip and will return about the middle of Febrnary.

E. E. Gilbert, manager of the turbine sales department of the General Electric Company, of Schenectady, N. Y., has arrived in San Francisco on a visit.

R. J. Cash, electrical engineer with the General Electric Company's Portland office, has gone North, after spending two weeks in San Francisco on business.

G. I. Kinney, San Francisco, manager of the Fort Wayne Electric Works, has just returned from a Pacific Northwest business trip of several weeks' duration.

Julian Thornley, a well-known Eastern engineer, is on the Coast and is looking over the Great Western Power Company's hydro-electric plant at Big Bend.

Edward L. Brayton, president and general manager of the Pelton Water Wheel Company, has returned to San Francisco from his annual visit to the New York office.

Wynn Meredith, of Sanderson & Porter's San Francisco office, has gone to New York, after spending several weeks in Victoria, B. C., and vicinity in connection with electric power plant extensions.

W. H. Leffingwell, engineer of the Mono Power Company, has returned to his office at Bishop, Cal., after spending a week in San Francisco, on business connected with the completion of a transmission plant on the Owens River.

Leon M. Hall, consulting engineer for the Comstock mines, has returned from a trip to Virginia City, Nev. Mr. Hall has removed his San Francisco office to room 1120 Kohl building, with the new firm of Hall, Demarest & Co.

Charles Blizard, third vice president and general sales manager of the Electric Storage Battery Company of Philadelphia, who spent some days at the San Francisco agency, besides visiting Los Angeles and Seattle, returned to the East during the past week.

D. R. Bullen, manager of the supply department of the General Electric Company, and C. W. Stone, assistant engineer of the lighting department, have arrived from Schenectady and will attend the annual meeting of the company's agents at the San Francisco office.

C. L. Cory, electrical engineer, has turned in to Chairman Loughrey of the Telephone Committee of the Board of Supervisors of San Francisco his third annual report on telephone charges. This is based on the operations of the Pacific States Telephone Company's plant.

E. P. Kennedy, assistant superintendent of the Alaska Treadwell Mining Company, spent the past two weeks in San Francisco, closing contracts for the equipment of a new hydro-electric plant which will utilize the water of Sheep Creek at a power site a few miles from the mines.

Theodore B. Comstock has been retained as consulting engineer to the Public Utilities Commission of Los Angeles, Cal. Mr. Comstock was formerly president of the University of Arizona and at one time was connected with the department of geology at Cornell University. For some time he has acted in the West in an independent consulting capacity.

R. B. Daggett has resigned as Pacific Coast manager for the Electric Storage Battery Company and has formed a new company, known as R. B. Daggett & Co., to enter the electric vehicle field. The new company will handle the Baker electric pleasure vehicles, Walker electric trucks, Elco motor boats and launches, Reed electric head-lights, and other specialties. It is operating electric garages in San Francisco, Mayfield, San Jose and Oakland, California.

MAP OF TRANSMISSION LINES.

In connection with the map of the transmission systems of California and Nevada, which was published as a supplement to the Journal of Electricity, Power and Gas, of Febrnary 5, 1910, it shonld have been stated that it represented only the hydro-electric power plants. In addition there are many steam plants snpplying power over long-distance lines such as the Ventura Connty Power Company of Oxnard, California, which is operating abont sixty miles of a 33,000-volt 50-cycle system with seven sub-stations throughout the county. In this respect the map is incomplete, which defect will be remedied in future editions.

TRADE NOTES.

O. E. Slater, of the San Francisco office of Smith, Emery & Co., inspecting and testing engineers, will go to Los Angeles to take charge of the new office, which is to be established at 245 South Los Angeles Street under the style of Smith-Emery Company. He will have four assistants at the start. The firm are converting the two-story brick building which they have purchased at the above location into a first-class physical and chemical testing laboratory. It is laid out on the lines of their local plant, but a new feature with this firm will be a complete equipment for electrical testing work of almost every kind.

Manager Grant of the Four Mining Company was in San Francisco last week closing contracts for an 800 h. p. hydro-electric plant on Mt. Whitney Creek near Keeler, Cal. It is understood that General Electric generators direct connected to impulse water wheels, operating under an effective head of 750 feet, will be installed. Current will be transmitted at 20,000 volts to Keeler, where the company's smelter and soda works are situated. In order to operate these and the electric hoists and air compressors at the mine, about 20 miles of pole line will be reqnired. Sidney Sprout is the consulting electrical engineer.

The Pelton Water Wheel Company secured the contracts for the two 1900 h. p. maximum-efficiency impulse wheels, to be direct connected to two 1,000 k. v. a. generators, which the Alaska Company will shortly install on Sheep Creek for an additional supply of power to their mills. The distance of transmission will be about five miles. Two direct rope drive Pelton units have also been purchased to supply power to the same Company's "Mexican" and "Ready Bullion" mills. The combined crushing capacity of all of the mills is 4800 tons of ore per day. Special attention will be paid to water wheel efficiency at fractional loads in the above equipment.

The General Electric Company reports the closing of electrical contracts for a hydro-electric transmission plant with the Alaska Treadwell Gold Mining Company for their Sheep Creek power development in Alaska. The electric equipment comprises: Two A. T. B. 18, 1000-kw., 400 r. p. m. 2300-volt water wheel driven generators; two 2-unit, 3-bearing motor generator exciter sets, each consisting of one I. 6, 50 h. p. 1200 r. p. m. Form K., 2200-volt, induction motors, direct connected to one D. L. C. 4, 35 kw. 125-volt, compound wound generator; six W. C. 60, 667 kw. 2300-volt, primary, 22,000-volt secondary transformers are also included with a 5-panel switchboard and a Tirrell regulator.

NEWS OF THE STATIONARY ENGINEERS

PREAMBLE.—This Association shall at no time be used for the furtherance of strikes, or for the purpose of interfering in any way between its members and their employers in regard to wages; recognizing the identity of interests between employer and employe, and not countenancing any project or enterprise that will interfere with perfect harmony between them.

Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the business of the Association, and at all times preference shall be given to the education of engineers, and to securing the enactment of engineers' license laws in order to prevent the destruction of life and property in the generation and transmission of steam as a motive power.

N. A. S. E. CONVENTION.

The seventh annual convention of the California State Association, National Association of Stationary Engineers, will be held in Los Angeles, May 23-28, 1910, on the fourth floor of the new Hamburger building, Eighth and Broadway. The committee has issued a diagram of floor space which contains complete information for intending exhibitors at the engineering and mechanical exhibition to be held in connection with the convention.

OREGON NO. 1.

The open meeting of Portland No. 1, N. A. S. E., on Feb. 2, 1910, was addressed by Mr. H. E. Harris of the Harris Ice Machine Works on the subject of refrigeration. Mr. Harris received the warmest approval for his efforts and the discussions following his address showed the interest taken by the engineers. Before the close of the meeting the chairman of the educational committee, C. E. Boswell, announced that at the open meeting on the evening of February 16th next, an address would be delivered on "Electric Elevators" by Chief Engineer C. H. McGirr of the Wells Fargo Building, and at the meeting two weeks later Manager Herbert E. Judge of the Valvoline Oil Company, an associate member of the association, would deliver an address on "Machine Oils."

PRACTICAL MECHANICS.

PAPER NO. 7.

Axes of rotation intersecting without meeting. In some cases of transmission between axes not parallel and not meeting it is practicable to use an intermediate piece or link as shown in Fig. 6. Here the crank pins are parallel to their respective axes and, since the angle of intersection of the axes is the same for all parts

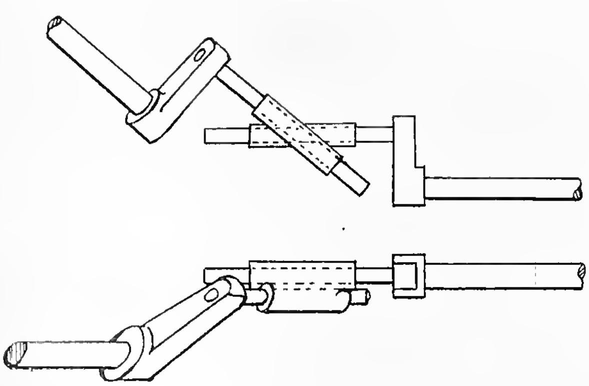


Fig. 6.

of the revolution, the pins must make a constant angle. The intermediate piece or block then is provided with long holes making this fixed angle. There is, of course, longitudinal sliding of the pieces in the holes, but this is often permissible and really facilitates lubrication. This mechanism often greatly simplifies transmission between two axes not meeting, but when an additional link is employed, as sometimes must be done, it becomes too complicated for efficient application.

Here, as also in the next succeeding device—the Hook's universal joint—the angular velocity relations are complicated, and there are, in some instances, dead center points which must be overcome.

Hook's universal joint is a familiar form of connection between rotating axes. The coupling consists of a forked or clevis-shaped attachment on the end of each shaft. The four bearings of these two forks fit the ends of an intermediate cross-shaped piece. Or this piece may be a disk with pins at each 90° on its circumference, or even a sphere is sometimes used. Whatever its form, the axes of its two pairs of bearings intersect in a point, and the forked ends of the shafts must be so adjusted that this point of intersection is at the point of intersection of the main shafts (extended). See Fig. 7.

The two sets of bearings AB and CD revolve in circles whose planes are perpendicular to their respective shafts. A little reflection will show that the relative angular velocities of the two shafts varies throughout each revolution. Suppose, for example, that shaft E were turning with a constant angular velocity. Then CD will be turning in a plane perpendicular to the paper and to the shaft E, i. e., the points C and D will have a certain, constant peripheral velocity. As rotation takes place it is evident

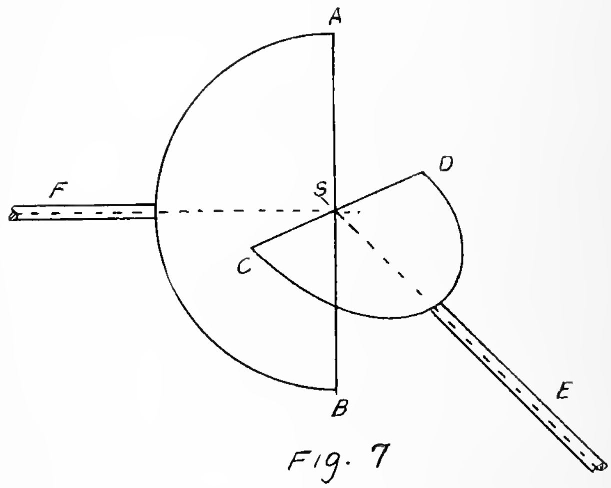


Fig. 7

that the radial distance of C or D from the axis of F is variable, being a maximum when CD is perpendicular to F and a minimum when AB is perpendicular to E. Now, since peripheral velocity is the product of angular velocity and radius, it follows that the angular velocity F must vary with the radius of the driving points C and D. There will be two points of maximum and two of minimum velocity during each revolution, the amount of variation between them depending upon the angle of intersection between the shafts.

In practice the shafts to be connected by a universal joint should not make with each other an angle greater than 30°, as otherwise the radial variation above mentioned becomes so great that excessive strains are made upon the pins and bearings. The complete mathematical solution of this angular variation forms an interesting problem in trigonometry and the differential calculus.

In order to transmit uniform angular velocity the double universal joint may be used. This is simply the addition of a second joint at the other end of shaft E, for instance, with the forked end set parallel to the existing one and the final driven axis or shaft making the same angle with E as the angle between E and F. It will be seen, therefore, that the double universal joint will permit of transmission between either parallel axes or (by making the angles 45°) perpendicular axes. By this means it will be seen that the angular variation given by the first joint are neutralized by the second one.

APPROVED ELECTRICAL DEVICES

ATTACHMENT PLUGS, FUSELESS

"G. E." 3 A., 250 V. Porcelain base types, Cat. Nos. 28840 (swiveling cap), 34153 (brass cap) and 50996. Composition, Cat. No. 48661 (weatherproof). Approved Jan. 5, 1910. Manufactured by

General Electric Co., Schenectady, N. Y.

CONDUIT BOXES

"Pipe Taplets." Cast Iron Outlet Boxes with threaded openings for standard sizes of rigid conduit. Cat. Nos. 4410-4414 incl., and 4170. For use with special porcelain covers or with suitable approved rosettes or receptacles. Approved for exposed work only; Jan. 5, 1910. Manufactured by

H. T. Paiste Company, 32d and Arch Sts., Philadelphia, Pa.

FIXTURES.

"Benjamin" Tungsten Arcs, Indoor and Weatherproof Forms. Cat. Nos. T-14, T-45, T-44-k, T-45-k, T-46-k, T-62, T-63, T-64, T-74, T-75, T-83, T-84, T-85, T-714, and T-715. Approved Jan. 13, 1910. Manufactured by

Benjamin Electric Mfg. Co., 507 W. Jackson Blvd., Chicago, Ill.

HEATERS, Electric.

Vulcan "Electrocurl" for use on 110-125 or 220-250 circuits. A curling iron with a removable heating element inside the case. Heating element consists of resistance wire wound on a lavite tube. Approved Jan. 13, 1910. Manufactured by

Vulcan Electric Heating Co., 69 W. Jackson Blvd., Chicago, Ill.

INSULATING PAINTS.

"S P C" Asphalt Varnish. For use as a protective coating especially for surfaces directly exposed to the weather. Approved Jan. 13, 1910. Manufactured by

Standard Paint Co., 100 William St., New York, N. Y.

MISCELLANEOUS.

Bell signaling system consisting of single stroke bells of special pattern connected to 110 or 220 volt lighting circuits. The bells may be connected in one or more series sets, these sets being connected in multiple with the supply circuit and in series with a special oil immersed contactor relay. The signals are transmitted by the relay, the magnets of which are energized by battery current. Approved resistances suitably mounted are used to limit the current flow through the relay to 10 A. Approved for use when the wiring of the gongs and relay is installed according to Class C of the National Electrical Code; Jan. 12, 1910. Manufactured by

Autocall Co., Shelby, Ohio.

"P. M." Meter Connection Blocks, not over 30 A., 125 V. Special porcelain cutout bases, with metal enclosing case; designed for preventing theft of current and to facilitate the inspection and test of service meters. Type A, with single piece enclosing case. Type E, with two piece enclosing case and with double pole indicating snap switch for use as service entrance switch. The enclosing cases of these devices are not considered as the equivalent of a cabinet for enclosing service entrance switches, when such cabinets are required. Approved Jan. 13, 1910. Manufactured by

Price-McKinlock Co., 156-160 Pearl St., Boston, Mass.

RECEPTACLES, STANDARD.

Wall Sockets, Brass Shell. Key, Cat. Nos. 140 and 142. Keyless, Cat. Nos. 141 and 143. Sign Receptacles, Cat. Nos. 212, 260, 265, 267, 268, 272, and "Russell" 280. Conduit Box Type, Cat. Nos. 210 and "Russell" 280. Cleat Type, Cat. No. 226. Approved Jan. 13, 1910. Manufactured by

E. H. Freeman Electric Co., Trenton, N. J.

RECEPTACLES, WEATHERPROOF.

"Bryant 3 A., 250 V. Cat. Nos. 9407, 9408, 9411, 30000, 44912, 59107, 59275 and Street Hood Sockets, Cat. Nos. 25706 and 25707. Also Cat. Nos. 9407, 30000 and 44912, for use with 110 or 220 volt lamps in series on 600 volt circuits. Approved Jan. 4, 1910. Manufactured by

The Bryant Electric Co., Bridgeport, Conn.

SOCKETS, STANDARD.

"P. & S." Brass Shell Sockets. Key, "Snap Cap" Cat. Nos. 440, 442 and 444, "Bayonet," Cat. Nos. 61059, 61060, 61063, 61065, 61157 (157), 61357 (357), 61457 (457), and 61557 (557). "Protectus" Cat. Nos. 100421, 100423, 100425, 100427-100429 incl. "Passmour," Cat. Nos. 100412, 100414, 100416, 100418-100420 incl. Keyless "Snap Cap" Cat. Nos. 441, 443 and 455. "Bayonet," Cat. Nos. 60157 (0157), 60357 (0357), 60457 (0457) and 60557 (0557). "Protectus" Cat. Nos. 100422, 100424 and 100426. "Passmour" Cat. Nos. 100413, 100415 and 100417. Also the above type with shade holders attached. Approved Dec. 31, 1909. Manufactured by

Pass & Seymour, Inc., Solvay, N. Y.

"Paiste" Brass Shell Sockets. Key, 50 C. P. 250 V. Cat. Nos 9386, 18386, 43389, 49386, 50760, 99386, 59480, 59481, 59484 and 59486, "Security Snap" 44147, 44148, 44814, Keyless, 3 A. 250 V. Cat. Nos. 9392, 19392, 43390, 49392, 50768, 99392, 59482, 59483, 59487, 59485, "Security Snap" 44149, 44150, 44815. Pull 50 C. P. 250 V. Cat. Nos. 61120 and 61121. Also above types with shadeholders attached. Approved Jan. 18, 1910. Manufactured by

H. T. Paiste Co., 32d and Arch Sts., Philadelphia, Pa.

SOCKETS, WATERPROOF.

"Bryant 3 A. 250 V." Porcelain shell; bracket style, Cat. Nos. 9448 and 9496; pendant, Cat. Nos. 9366, 50997 and 59107. Composition shell; bracket style, Cat. Nos. 43311-43314 incl., pendant, Cat. Nos. 42686, 43310 and 60666. Hard Rubber Shell; pendant, Cat. Nos. 42690 and 50788. Also Cat. Nos. 9366, 42686, 42690, 43310, 43312, 43313, 43314, 50788, 50997 and 60666, for use with 110 or 220 volt lamps in series on 600 volt circuits. Approved Jan. 4, 1910. Manufactured by

The Bryant Electric Co., Bridgeport, Conn.

SWITCHES, AUTOMATIC,

Automatic Time Switches. Type No. 20, 20 A. 250 V. Type No. 30, 30 A. 250 V. This device consists of an approved double pole snap switch connected directly to a clock mechanism. A sheet metal case is provided which encloses the clock and switch mechanism. Approved Jan. 13, 1910. Manufactured by

Reliance Automatic Lighting Co., Warren, Ohio.

SWITCHES, FIXTURE.

Fixture Arm Switch, single pole ½ A. 125 V., Cat. No. 3200. Approved for fixture arms only (not canopies) for control of one 16 c. p. 110 v. lamp, and when wired with solid (not stranded) wires; Dec. 28, 1909. Manufactured by

Pass & Seymour, Inc., Solvay, N. Y.

SWITCHES, PENDANT SNAP.

"P. & S." pendant switches, 3 A. 250 V., 6 A. 125 V. Approved Dec. 28, 1909. Manufactured by

Pass & Seymour Inc., Solvay, N. Y.

WIRES, RUBBER COVERED.

Tag on coil to read, "Nat'l Elec. Code Standard." Marking: One yellow and one green thread twisted together running parallel with wire between rubber insulation and braid; black core. Approved Dec. 22, 1909. Manufactured by

Rome Wire Company, Rome, N. Y.

INDUSTRIAL

AUTOMATIC CONTROL OF MOTOR DRIVEN PUMPS.

In this age of electricity where power and lighting lines span the country in every direction, much of the drudgery of the home life is fast disappearing and the electric motor is becoming an indispensable part of the household equipment. This little device has robbed the sewing machine of its terrors and transformed tedious, laborious, back-aching toil into work that it is a pleasure to perform. It has usurped the place of the laundry maid and performs all the laborious work of washday. In many other ways it is eliminating toil and contributing to the pleasures of life.

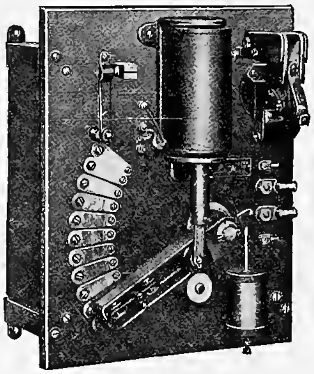


Fig. 1. General Electric Self-Starting Controller.

One of its most interesting applications is to the performance of operations which are of so rare occurrence as to make the presence of an attendant an expensive luxury. For such service electricity is an ideal source of power, as it admits of automatic control, is always ready for instant use, and costs nothing except when it is being used. There is no delay waiting to get up steam and its use is not attended with odor, noise, or steam. The motor and controlling apparatus occupy very little space and may be installed on the wall or ceiling where it will be out of the way. Such a device, becomes a servant that needs no watching and never forgets.

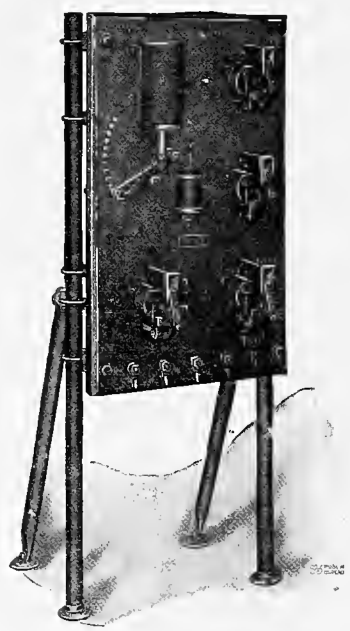


Fig. 2. General Electric Self-Starting Controller for large D. C. Motors.

An excellent example of the utility of the electric motor equipped with automatic control is its application to the operation of pumps required to maintain a certain water level in a tank. If the water level falls below a certain predetermined value the controlling device automatically starts the motor and the pump continues to operate until the water level is raised to a predetermined value when it ceases to operate.

Figs. 1 and 2 illustrate a device manufactured by the General Electric Company, Schenectady, N. Y., for the service described above, while Fig. 3 shows the manner of its operation. The length of the chain attached to the ball of the float switch is so adjusted that when the water level falls below a certain point, the arm of the float switch is raised sufficiently to close the motor circuit and start the pump which continues to operate until the ball rises and allows the weight to carry the arm of the float switch down far enough to open this switch and disconnect the motor from the line. From Fig. 3 it is easily seen that the length of the chain and the position of the button on it may be adjusted so as to make the water level at which the motor starts and stops anything desired.

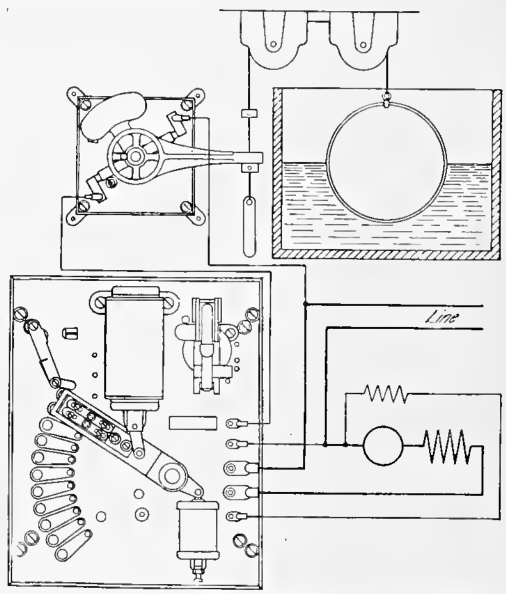


Fig. 3. Connections of General Electric Controller With Float Switch.

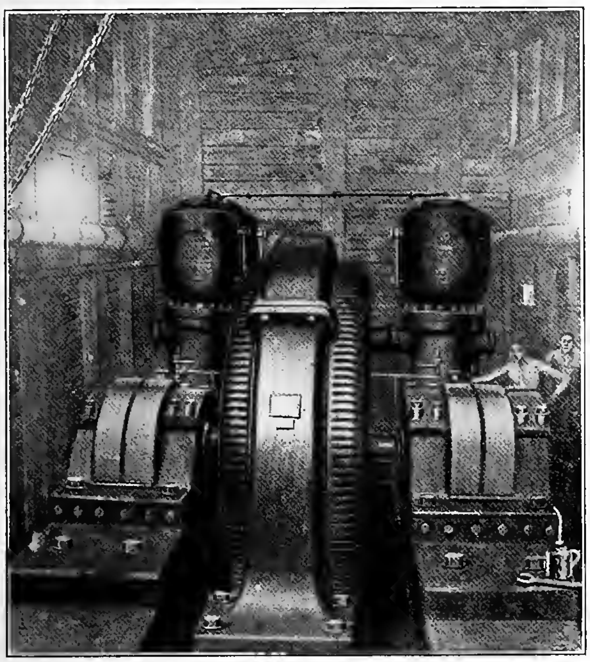
Except in smaller sizes the motor circuit is opened by an auxiliary switch provided with a strong magnetic blowout device which prevents an arc forming when the motor is disconnected from the line and eliminates any fire hazard that might result from a poorly designed piece of apparatus.

The same device will operate to maintain any desired fluid or air pressure if supplied with a pressure governor instead of a float switch. The General Electric Company have such a controlling device for every type of motor.

A LARGE ELECTRIC MINE PUMPING INSTALLATION FOR HANDLING HOT WATER.

In reopening the Ward shaft at Virginia City, Nev., a considerable flow of hot water was encountered, which for a time baffled the efforts of the workmen. The great depth of this shaft, 3480 feet, and the high temperature of the water, 175 degrees, made the work of pumping out the impounded quantity very difficult, but a temporary electric pumping outfit was finally successfully put into commission, and has since been supplanted by a permanent installation which easily handles the present continuous hot flow.

For emptying the mines, in the first place, a temporary motor-driven pump equipment was installed, by which compressed air driven sinker pumps at the bottom of the shaft lifted the water to a centrifugal pump on the 2330 ft. level. This in turn delivered to a vertical triplex pump on the 2100 ft. level. The sinker pumps were supplied with compressed air from two 100 h. p. Ingersoll-Sergeant compound air compressors driven by 100 h. p. Westinghouse motors located on the surface. The three-stage Byron Jackson centrifugal pump on the intermediate level was belted to a 50 h. p. Westinghouse induction motor, while a 100 h. p. type "C" Westinghouse induction motor drove the 6¾ x 8 in. Knowles vertical triplex pump at the uppermost pumping level.



Electric Pumps in the Ward Shaft.

This apparatus has since been replaced by the installation of the permanent pumping plant located in a pumping station 80 ft. long, 24 ft. wide and 20 ft. high, connected with the shaft 3100 ft. below the surface. The permanent pumping equipment consists of a special slow speed, 800 h. p. Westinghouse type "HF" induction motor direct connected to a Knowles express type, duplex, double-acting pump, operated at 195 r. p. m.

The valves are of the automatic poppett type arranged in nests of 13 each, presenting a valve area of 104 square inches, which makes necessary very slight movement of the valves, and is conducive to a high speed and a minimum of wear. The valves and other visible parts are of bronze, and the pump has a capacity of delivering 1600 gallons per minute against a total head of 1550 ft.

The plant is equipped with a three-stage electrically driven air compressor for charging the air receivers, besides a vacuum pump and an automatic oiling system. For convenience of erection and repair, the pump station will be fitted with a 15-ton traveling crane; in fact, it is intended to include in this plant everything that will insure reliability and ease of operation.

The over-all dimensions of each pump are 27 ft. 3¾ ins. in length, 17 feet in width, and 14 ft. 2 ins. in height. The motor is 13 ft. in diameter, and the steel crank shaft, forged from one piece, is 13¾ ins. in diameter and 14 ft 4½ ins. long. The total cost complete for operation was about $125,000. These pumps are supplied by either one of the two centrifugals located in the sump at the bottom of the shaft, and operated by special 75 h. p. Westinghouse motors on a vertical shaft.

The water is discharged through a 16-inch steel column with welded steel flanges. The thickness of this pipe varies from ¼-in. at the tunnel level to 9/16 in. at the bottom. The column is supported by means of heavy weight iron clamps six inches in length, which in turn rest upon the wall and end plates. To resist the pressure of 675 pounds to the square inch, male and female flanges are used and each fitted with a lead-filled copper gasket.

The electric current is taken down the shaft at 2240 volts over a three-conductor, lead-covered, steel-armored cable of 400,000 circular mils capacity. The electrical equipment, from the automatic oil circuit breakers on the surface to the motors themselves, is the best that money can buy; and in operation, with the Westinghouse machine of the Truckee River Electric Company behind it, results have been obtained never before approached for this class of work.

The accompanying illustration of the present permanent pump house, 3100 feet underground, was retouched from an actual flashlight photograph obtained during a recent visit to the mine. The normal temperature of this pump room, 110 degrees F. is attested by the costume of the men, who work their daily shifts of twelve hours under these conditions.

TRADE NOTES.

The Pacific Gas & Electric Company has purchased from the General Electric Company an additional three-bearing motor-generator set for the Temescal sub-station in Oakland. It consists of one M. P. C. 4, 500-kw., 720 r. p. m. 600-volt shunt and compound wound generator direct connencted to an A. T. I. N. 530-kw. 4300-volt synchronous motor.

C. D. Boyd has been appointed Michigan representative of the Kellogg Switchboard & Supply Company, with headquarters at Grand Rapids, Mich. C. Morsman has been transferred from the Michigan territory to the newly created Rocky Mountain district. B. Woodbury has been transferred from Minnesota to the Ohio district, with headquarters at Columbus. E. G. Lawrence has been appointed Minnesota representative. G. A. Joy has been appointed sales engineer, territory west of Chicago, Ill.

The Pierce Phosphate Company is installing a 1150-horsepower Westinghouse gas engine driven alternator set in its new generating station at Pierce, Fla., to serve as an auxiliary to the old power plant containing a number of Deisel oil engines. The new equipment consists of a 1150-horsepower Westinghouse single-crank horizontal gas engine, with cylinder 34 by 42 inches, direct-connected to a 850-kilovolt-ampere Westinghouse alternating current generator, supplying three-phase power at 2300 volts for hydraulic mining work. The engine is furnished with fuel gas from double-zone producers, having a calorific value of 110 B. t. u. per cubic foot. The new addition to the power plant equipment represents an expenditure of about $75,000, and will operate in parallel with the old station, built some six years ago, which contains six 200-horsepower Diesel gas engines driving 150-kilowatt alternators. The installation of the additional equipment is being made under the direction of Mr. A. H. Nickerson, mechanical engineer for the Pierce Phosphate Company, Pebbledale, Fla.

NEWS NOTES

FINANCIAL.

SEATTLE, WASH.—The Council finance committee has agreed to submit the issuance of bonds for $1,030,000 for water extensions to a vote.

MIDLAND, TEX.—Midland is to have a water system costing $50,000. Bonds have been passed upon and approved. They will be placed on sale March 7th. Bids for construction will be open about March 1st.

SEATTLE, WASH.—E. H. Rollins & Son and A. B. Leach & Co., of Chicago, were successful bidders on the $200,000 lighting plant bonds and $500,000 park bonds, offering a premium of $16,450 for 4½ per cent bonds.

LOS ANGELES, CAL.—The town of Lompoc is agitating a scheme of buying the electric light plant and system of which J. T. Worthington is the manager. The Trustees and business men are in favor of calling a bond election to vote bonds for buying the system.

EL CENTRO, CAL.—The City Council has passed an ordinance calling a special election to be held on February 14th for the purpose of submitting to the voters of the city the proposition of incurring a debt of $69,000 for the purpose of acquiring municipal waterworks.

SEATTLE, WASH.—The proposition of issuing $73,000 in water bonds for Kent was carried at a special election, the vote being 197 for and 16 against. The system itself will be bonded to the extent of $50,000 of the whole issue and the town will assume $23,000 of the indebtedness.

LOS ANGELES, CAL.—The City Council has passed an ordinance ratifying and confirming the sale and delivery to Kountze Bros. and A. B. Leach & Co. of New York, of $1,020,000 Water Works bonds of the city, being part of the issue of $23,000,000 authorized at a special election on January 21, 1907.

PLEASANTON, CAL.—A special election will be held in Pleasanton, Cal., on February 8th, 1910, at which time will be submitted the proposition of issuing and selling bonds in the amonnt of $40,000. Thirty-five thousand dollars of the amount is to construct a sewer system, and $5000 is for completing the water system, the acquisition, constrnction and completion of additional pipes and one additional reservoir.

LOS ANGELES, CAL.—The City Council passed a resolution providing for the issuing of bonds of the city in the sum of $4,896,000, being part of the issue of $23,000,000 bonds authorized by the voters at a special election held January 12, 1907, for the purpose of acquiring and constructing a certain revenue producing municipal improvement waterworks for supplying the inhabitants of the city with water from the Owens River Valley.

NEWPORT, CAL.—The City Clerk is receiving sealed bids for 40 bonds, each for the sum of $1000, known as Municipal Water Works Bonds, and 25 bonds each of $1000 known as Municipal Light Works Bonds. Each and every one of said bonds bear interest at the rate of 5 per cent per annum, payable semi-annually on August 1st and February 1st of each year after February 10. The certified check must be 2 per cent of the amount bid.

OAKLAND, CAL.—The annual report for 1909 of the receipts and disbursements of the People's Water Company in Oakland gives the net income for the year 1909 as $556,045.91. The detailed report of receipts gives the following figures: Water rents, $939,370.44; tapping, $27,022.45; turning on, $94; land rents, $26, 525.86; total receipts, $993,012.75. The operating expenses for the year detailed were: Supply, $22,456.13; distribution, $96,494.68; repairs, $22,507.53; general expenses, $126,685; administration, $9900; services constructions, $12,674.01; guarantee deposits, $120; total, $290,838.06. The taxes for the year 1909 paid by the company as recorded amounted to $69,257.35. In addition back taxes for the years 1903 and 1904 were collected from the company, making in all $146,128.78 in taxes. This brings the total expenditures to $436,966.84, leaving a balance on the year of $556,045.91. The report does not show what payments were made from this amount on the bonded interest account. The report for Berkeley shows receipts for the year 1909 as follows: Water rentals, $239,733.77; tapping, $8,011.50; land rentals, $7869.02, making a total of $255,654.92. The expenses amounted to a total of $111,371.30. With the payment of taxes amounting to $13,469.11, the net receipts are given as $130,813.88 on a property valuation given as $2,878,888.84.

INCORPORATIONS.

SANTA MONICA, CAL.—The Rand Power & Irrigation Company, with $10,000 capital; directors are: Ehrman and H. H. Grigsby, R. M. Miller, H. J. Engelbrecht.

SACRAMENTO, CAL.—The Sheldon Townsite and Realty Company has been incorporated at Sacramento for the purpose of building a town at Sheldon, on the line of the Central California Traction Company, which will operate an electric line between Sacramento and Stockton. The company will install its own electric lighting power and waterworks. The incorporators are: G. W. Peltier and F. W. Kissel, Sacramento; and J. C. Coffing of Florin.

TRANSMISSION.

EVERETT, WASH.—It is reported that the Sultan Railway & Power Company will install a power plant at the head of Sultan Canyon.

LOS ANGELES, CAL.—The Southern California Edison Company has asked the Board of Supervisors for a franchise for a large number of electric transmission lines in the county.

CITY OF MEXICO, MEX.—An application has been made by Aristides Betancourt for a concession to start a factory for making dynamos, electric machines, motors, transformers and all classes of transmission machinery. The department of fomento has the application under consideration.

LOS ANGELES, CAL.—Sealed bids are being received by the Board of Supervisors for furnishing and erecting power line transformers and a transformer house. The line is to extend from the San Fernando sub-station of the Southern California Edison Company to the transformer house to be erected near the Pacoima rock quarry.

SPOKANE, WASH.—In order to insure a more absolute continuity of power, the Washington Water Power Company is installing a storage battery, adjoining the new Post street sub-station, which will be one of the most expensive and modern improvements made by the company. The battery will be in operation before next winter.

COMPTON, CAL.—The City Council has passed an ordinance granting to the Consolidated Utilities Company, the right to construct and for a period of 30 years, operate and maintain poles and wires and other apparatus for use in furnishing electrical energy for lighting, heating and power purposes over the streets and highways of this city.

SANTA FE, N. M.—The County Commissioners of Taos County have granted to the Rio Lucero Power Company, of

which Territorial Coal Oil Inspector Malaquias Martinez is president, a franchise giving the company the right to extend its line and transmit power throughout the county. The company will furnish electric light to Taos and neighboring points.

TACOMA, WASH.—Nome advices state that Scotch capitalists have purchased the Nome electric light and power plant owned by the John J. Sesnon Company. The plant was taken over in November and placed under the new management, with Arthur Gibson in charge. The purchasers are represented in Nome by Stuart Weatherly and Fox Ramsey, who have incorporated the Seward Peninsula Power Company and who intended this year to furnish power for mining purposes and lights for Nome and other Seward peninsula mining camps. A new plant will be built on the sand spit west of Snake river. Turbine engines will generate the power which will be transmitted by pole lines and cables. These will be extended many miles to creeks and beach lines where the power will be used for hoisting purposes and dredging. The pole line will be run to Solomon, 40 miles distant.

TACOMA, WASH.—The first lumber mill on the Pacific Coast to be equipped throughout with electric motor drive is now being built at Union Mills near Lacey, twenty miles west of Tacoma by the Union Lumber Company. The entire equipment for this mill, both the electrical and saw mill machinery is being furnished by the Allis-Chalmers Company. Current will be generated by a 750 k. w., 480 volt, 60 cycle, 3 phase, 3600 r. p. m. alternator directly connected to a steam turbine which receives steam at 150 lbs. pressure and discharges into a vacuum of 26 inches. Excitation is usually furnished by a 15 k. w. motor generator exciter set. A 35 k. w., 120 volt, direct current generator is directly connected to a 9 in. x 9 in. vertical engine and will furnish direct current for lighting and excitation when the turbo generator is being started. A two-panel switchboard is provided.

ILLUMINATION.

FOREST GROVE, ORE.—Hans Peterson, of Forest Grove has decided to install a light and water plant here.

BRANDON, ORE.—The Brandon Light & Power Company is making plans to double its equipment and install new lamps.

BANNING, CAL.—An election will be held here soon to vote on the question of establishing and maintaining a system of street lighting.

POMONA, CAL.—An artistic lighting system for the business section of the city is under consideration by the Business Men's Association.

PASADENA, CAL.—The City Council's request of the city light superintendent to purchase supplies to the amount of $1336.30 has been allowed.

TACOMA, WASH.—The Cameron Electric Company has been awarded the contract for furnishing Tacoma with $25,000 worth of electric lamps.

COQUILLE, ORE.—Bids will be received up to March 2, for installing a steam heating plant, etc., in the court house. Plans prepared by E. G. Perham.

FLORENCE, ORE.—T. J. Monroe of Coos Bay has applied to the City Council of Florence for a franchise to build and operate an electric light plant there.

THE DALLES, ORE.—J. D. Wilcox of Portland has been granted a 30-year franchise to conduct a gas plant here. Construction is to begin in the near future.

EVERETT, WASH.—The Everett Gas and the Snohomish Gas Works have been purchased by the Tacoma Gas Company. Extensions and improvements will be made in both plants.

PORTLAND, ORE.—It has been decided by the Alder Street Improvement Association to place cluster lights on the curb for the entire length of the street.

POMONA, CAL.—A committee composed of representative business men has completed plans for extensive improvements in the lighting system of Pomona.

DIXIE, IDAHO.—S. R. Gayton of Philadelphia, identified with the Penn-Dixie Mining Company, has purchased the Dixie townsite and will install an electric plant this summer.

BANDON, ORE.—The Bandon Light & Power Company, owner of the electric light plant of this city, is making preparations to enlarge the service to about double the present capacity.

FULLERTON, CAL.—J. R. Carhart and G. C. Ivy have purchased practically all of the stock of the Home Gas Company, of this city, for about $18,000. They will make a number of improvements and install new machinery.

SIERRA MADRE, CAL.—The City Clerk is receiving sealed bids for a gas franchise in this city. The franchise is good for 50 years and includes the right to construct underground conduits, mains and gas pipes in public streets.

CITY OF MEXICO, MEX.—F. W. Walser of Cleveland, O., president of the A. & W. Sign Co., is expected here next week for a conference with the centennial officials relative to the lighting of the city during the centennial celebration this fall.

LOS ANGELES, CAL.—The Trustees of Hermosa Beach have closed a contract with the Edison Company for the installation of arc lights on all thoroughfares where street work is in progress, which calls for an expenditure of more than $250,000.

EUGENE, ORE.—John Hunzicker, the architect and superintendent for the new Osburn hotel, is arranging plans for an independent light and power plant to be installed in the basement of the hotel to supply light for the house and power for the elevator.

ALHAMBRA, CAL.—The Board of Trustees is receiving bids for furnishing ornamental cast iron posts to be equipped with incandescent electric lamps, and necessary wires, connections and fixtures for lighting Main street between the center line of Third and the center line of Monterey.

SEATTLE, WASH.—Sealed proposals are being received by C. B. Bagley, secretary of the Board of Public Works, for the installation of a complete system of cluster lights along Broadway and North Broadway, from the north line of East Pike street to the south line of East Roy street.

GLENDALE, CAL.—The distribution of gas pipes along one of the main streets by the Domestic Gas Company of Los Angeles and the report that it will lay mains through three principal streets with laterals to all parts of the city, are the latest developments in the lighting situation here.

SANTA BARBARA, CAL.—It is given out that as a result of a conference between the directors of the Edison Company and the Mayor and Council the company will spend $211,000 for a new gas plant four times the size of the present one. About $150,000 more will be devoted to the extension and improvement of the local trolley system.

PHOENIX, ARIZ.—On February 24th an election will be held in this city for the purpose of determining whether or not the Common Council shall apply to Congress for authority to issue bonds of this city in a sum not exceeding $300,000, for the purpose of constructing, or acquiring by purchase, an electric light, gas and power plant for supplying this city.

SANTA BARBARA, CAL.—The City Clerk is receiving sealed bids for 172 arc lights known as 2000 candlepower and 42 incandescent lights of 16 candlepower to be located where the same are now located, and for such additional

lights as the city may from time to time order, in such places as may be determined and under the same conditions in the contract of the city with the Edison Electric Company.

SEATTLE, WASH.—Sealed proposals are being received for the installation of a complete system of cluster lights along Union street, along Hubbell Way, Pike street, Fourth avenue, Fifth, Sixth, Seventh, Eighth and Ninth avenues, Terry, Bordon, Minor and Melrose avenues, Bellevue, Summit, Belmont, Boylston and Harvard avenues.

SEATTLE, WASH.—The Seattle Lighting Company, of which S. R. Hutchinson is superintendent, will make Georgetown the distributing point for the whole south eud district by laying over five miles of new mains; $125,000 to be expended. A steel gas holder with a capacity of 1,000,000 cubic feet has been ordered. A two-story brick and cement office building will be erected.

REDLANDS, CAL.—H. B. Duncan, secretary of the San Bernardino Valley Gas Company, states that the company will construct a generating plant at Colton and manufacture gas to be used in Colton and Redlands. Should it be advisable the company will construct a high-pressure line from Colton to Corona, but the natural course will be from Colton to Highgrove, through Riverside and Arlington, and from Arlington to Corona.

ELLENSBURG, ORE.—The electric light committee of the City Council and the superintendent of the municipal plant have formulated plans for the improvement of the present plant, located on the Yakima river two miles west of the city. They will install a steam auxiliary plant and enlarge the power canal carrying water from the river into the turbine. No definite action will be taken on the power canal improvements until a city engineer is appointed.

LAS CRUCES, N. M.—It is announced that the purchase of the Las Cruces Electric Light & Ice Company is pending and that the holdings of the local company would be taken over by an eastern concern providing a franchise can be obtained. J. B. Downey, representing eastern capitalists, arrived here recently and has assumed active management of the company's plant. G. W. Morgan will arrive in a few days and will be permanent manager if the deal goes through.

TRANSPORTATION.

MONTESANO, WASH.—The Grays Harbor Interurban Company has applied for a franchise for the construction and operation of a line of interurban railway over county roads in Chehalis county.

GUADALAJARA, MEX.—The Chapala Hydroelectric and Irrigation Company is now considering the construction of an electric railroad from Guadalajara to Aguascalientes. No definite steps have been taken.

LOS ANGELES, CAL.—A petition for offering for sale of a franchise for a trolley line on South Park avenue over the route rejected at the last election has been referred to the public utilities commission.

SPOKANE, WASH.—Big Bend Transit Company expects to begin construction in the spring of an electric road from the mouth of Spokane river to this city, according to the announcement of W. A. Nichols.

BERKELEY, CAL.—Attorney M. R. Jones, representing the East Shore and Suburban Railway Company, has filed an application with the Albany Trustees asking for a franchise for an electric street car line. The company is to operate lines from Point Richmond and through Albany as follows: South along San Pablo avenue, thence west and south to connect with the northern end of the S. P. loop extending out from Berkeley. The franchise, if granted, will link Richmond, Stege, San Pablo, Rust and Point Richmond with the S. P. electric system, connecting with San Francisco, and will fill in the last remaining gap in the bay cities on this side.

WATERWORKS.

DORRIS, CAL.—The Trustees are negotiating with the United Iron Works of Oakland for a system of waterworks.

VALLEJO, CAL.—The Board of Public Works has decided not to purchase 500 water meters for the use of water consumers in this city.

SACRAMENTO, CAL.—City Engineer Randle has recommended that 1040 feet of wrought iron water pipe be purchased for the South Side Park.

SEATTLE, WASH.—The City Council has passed a number of ordinances and resolutions preparatory to the laying of water mains in a large number of streets.

PORTLAND, ORE.—Sealed proposals will be received at the office of the City Clerk until 10 o'clock a. m., February 15th for the furnishing of all material and labor for the construction and completion of a city waterworks system.

REDLANDS, CAL.—Steps have been taken to organize a new water company of the Crafton Heights ranchers and to rebuild a pipe line washed out several years ago by a flood. A survey just completed, shows that the work will cost $20,000.

EL CENTRO, CAL.—The City Council has passed a resolution determining that public necessity demands the acquisition, construction and completion of a municipal waterworks and water system and that bonds will have to be issued for said improvement.

VALLEJO, CAL.—Authority having been received from the Board of City Trustees, City Clerk Tormey has been authorized to advertise for 2000 feet of 4-inch pipe and six fire hydrants which are to be used in improving the fire protection system in the northern section of the city.

PHOENIX, ARIZ.—Bids have been opened by the Board of Control for the construction of water tanks at the territorial prison. There were six bidders ranging in amount from $6000 to $2800, though the latter bid was only for material. The award was tentatively made to Des Moines Bridge & Iron Works, at $3495.

CALEXICO, CAL.—The Board of City Trustees have opened bids as follows for the new municipal water system: Fairbanks-Morse Co. of Los Angeles, $13,675; Harper Reynolds Co., Los Angeles, $15,180; Crane Co., Los Angeles, conditional bid, $13,550; R. H. Boyton Co., Memphis, Tenn., $13,-175.75. The last named bids will be accepted.

CENTRAL POINT, ORE.—Sealed proposals will be received by the town recorder of Central Point, Ore., until February 15, 1910, for constructing waterworks, work to consist of hauling and laying steel pipe, valves, valve boxes, hydrants, special castings, pump, motor and water tower for a distributing pipe system, all labor and material to be furnished by the contractor.

PORTLAND, ORE.—Plans and specifications for the proposed new pipe line from Bull Run to Portland have been completed by Engineer Clarke of the City Water Department. According to Mayor Simon, bids will be asked for building this aqueduct, and the contract let within the next few weeks. The new line will parallel the one now in use and will have a capacity of 40,000,000 gallons daily.

BAKER CITY, ORE.—An ordinance has been passed instructing the city engineer to prepare estimates of the cost of improving the upper pipe line by replacing the 8.11 miles of flume with a substantial pipe, the building of a parallel line from the settling tank to the city reservoir, and the construction of a twin reservoir near the present one. When the estimates have been made, the question of voting bonds for the improvement will be submitted to the taxpayers.

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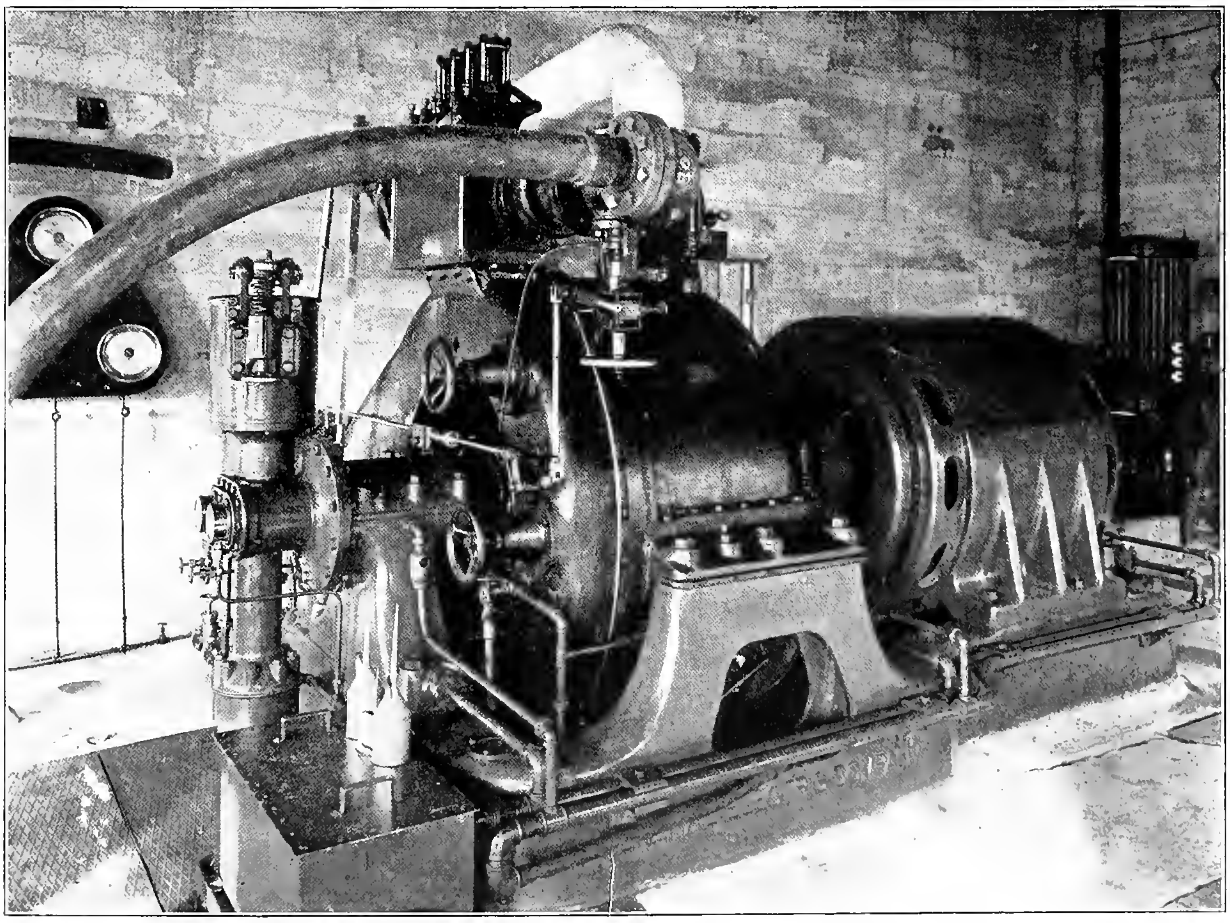
LOW PRESSURE STEAM TURBINES.[1]

BY EARL O. SHREVE.

We are living in an exceedingly progressive age. We have seen the bipolar generator superseded by the efficient multipolar; belt drive changed to direct drive; the single truck street car give way to the modern car; the steam turbine replace engine generating sets, and many other important changes, but in no other case, I believe, have the possibilities been so great with so little first cost and without the necessity of discarding other apparatus as with the exhaust or low pressure turbine.



Mixed Pressure Turbine of E. K. Wood Lumber Co., Bellingham, Washington.

The high pressure steam turbine has revolutionized, in a very short time, the new steam electric generating plants, until today there are in operation, in the United States, steam turbines having an approximate

[1]Paper read before San Francisco Section, A. I. E. E., January 28, 1910.

aggregate capacity of 2,500,000 kw. The low pressure turbine offers economical possibilities for existing engine plants operating condensing or non-condensing which demand consideration, whether the engine is generating electricity, driving cotton mills, rolling mills, for hoisting plants, or for any use.

The steam engine is a very efficient piece of machinery when using steam from a high pressure and exhausting to atmosphere, but, from atmosphere down, it has inherent limitations which do not allow of the most efficient use of the steam. A good compound engine will not have space for expansion to more than fifteen times its original volume and a triple expansion more than thirty-five, whereas steam expanded adiabatically from 150 lb. to 28 in. vacuum increases in volume 96 times the original.

A steam engine, at best, can get only about 70 per cent of the energy from the steam. There are a great many engine plants operating non-condensing with steam consumption averaging 35 lb. per kw.-hour because, for the extra efficiency gained, the owners cannot afford to install condensing and auxiliary apparatus.

A very interesting paper on "Steam Engine Economy," read by Prof. J. E. Denton, in 1904, before the Mechanical Section of the International Congress of Arts and Sciences at St. Louis, gives the following: "The most economical piston engines, which, as we have seen, expand steam about thirty times, release their steam at the end of the stroke at 6 lb. absolute pressure; but they exhaust into a condenser which, with a vacuum of 28 in., contains a pressure of 1 lb. absolute per sq. in. If the expansion could continue until the pressure of 1 lb. was attained before exhaust occurred, considerable more work could be obtained from the steam. This, however, cannot be done in piston engines for two reasons; first, because the low cylinder would have to be about five times greater in volume, which is commercially impracticable, and second, because the velocity of exit through the largest exhaust ports possible is so great that the frictional resistance of the steam makes the back pressure from 1 to 3 lb. higher than the condenser pressure in the best engines of ordinary piston speed."

With a turbine, different conditions exist. It is the simplest form of turbine, having only the low pressure wheels, can be made amply large to take advantage of the best vacuum obtainable, has minimum radiation losses, and the lowest rotating loss that could exist because of working in a comparatively rare gas. Because of valve leakage, etc., in the engine, it is better practice to design the turbine to take steam at 1 lb. gauge pressure.

It is interesting to note that the amount of available energy in steam from 150 lb. to atmosphere and from atmosphere to 28½ in. vacuum is about the same, being 132,000 foot pounds per pound of steam in the former and about 130,000 foot pounds in the latter, allowing about 8 per cent for moisture.

There is just as much energy in steam expanded from 2 lb. to 1 lb. absolute as from 200 lb. to 100 lb. gauge. These results may be verified by a study of the adiabatic and isothermal expansion curves. From these facts, we readily see that almost unbelievable increases in efficiency may be obtained by combining the turbine with the engine.

To show the exact nature of what may be expected, I wish to introduce an interesting curve (Fig. 1) obtained from tests of a 22x44x42 Rice Sargent engine with d. c. 250 volt generator, and results obtainable from combining with a. c. low pressure turbine. At full load on the engine (1200 kw.) non-condensing, about 1000 kw. could be obtained from the exhaust steam by means of a low pressure turbine, which is a gain in capacity of 83 per cent.

At 2200 kw., or combined full load, the water rate is 16 lb. per kw.-hour and, as the engine running condensing uses 23 lb. and non-condensing 32 lb., we have an increase in efficiency of 30 and 50 per cent respectively with absolutely no increase in steam consumption over that of the engine when working condensing.

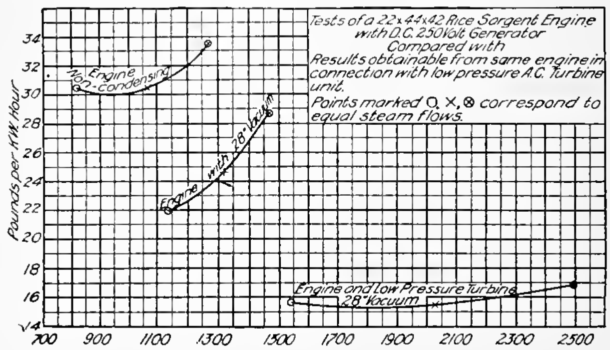


Fig. 1.

While, as stated before, many stations are operating non-condensing because it would not be advisable to install condensing apparatus to secure the small gain possible, it is evident that, with such a gain as obtainable in the above case, the extra expense would not only be feasible but almost demanded. An outline of the results that might be expected from a proposed installation of a mixed pressure turbine might be of interest here.

Engine capacity condensing 1200 h. p.; non-condensing without changing valves 880 h. p.; with steam consumption of about 22,000 lb. per hour. With these conditions, and exhausting the turbine to 28 in. vacuum, we obtain the following results:

Engine h. p.	880	Increased capacity	42.7 per cent.
Turbine h. p.	690	Increased efficiency	30 per cent.
Total output	1570	same fuel.	

Working under same conditions but with enough live steam to generate a total of 750 kw .with the turbine, we have these results:

Engine h. p.	880	Increased capacity	76.5 per cent.
Turbine h. p.	1060	Increased efficiency	23 per cent.
Total capacity	1940	Increased steam consumed	34 per cent.

Working under the same conditions but resetting the valves so that full condensing capacity may be obtained from the engine operating non-condensing in connection with low pressure, we have:

Engine h. p.	1100	Increased capacity	74.5 per cent.
Turbine h. p.	820	Increased efficiency	35.8 per cent.
Total capacity	1920	Increased steam consumpt'n.	20 per cent.

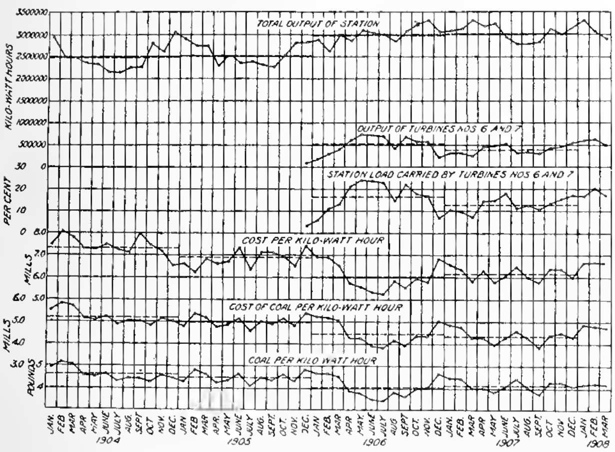
Additional live steam for 750 kw.:

Engine h. p.	1100	Increased capacity	96.4 per cent.
Turbine h. p.	1060	Increased efficiency	27.9 per cent.
Total capacity	2160	Increased steam consumpt'n.	41.8 per cent.

Of course, if this engine had been running non-condensing, the per cent increase in efficiency would have been nearly double.

It is an erroneous idea to assume that the engine with the poorer economy will give the most efficient combination result. The maximum economy depends just as much on the engine utilizing the steam to the very best advantage, obtaining the maximum amount of energy available, as upon the efficient operation of the turbine. The gain in capacity would be greater with inefficient engines and, as in some cases this end is desired, it may, sometimes, be of advantage to set the valves so as to pass a greater amount of steam than when set at the most economical point, but, where maximum efficiency is the object, the most efficient engines give the better results.

Each installation requires careful and independent study as there are so many variable features which enter into an increase of this kind and the nature of the installation depends in every case upon the results desired, i. e., whether it is desired to increase the normal capacity, to increase the overload capacity, to obtain better economy without increase in load, or any combinations of the above.



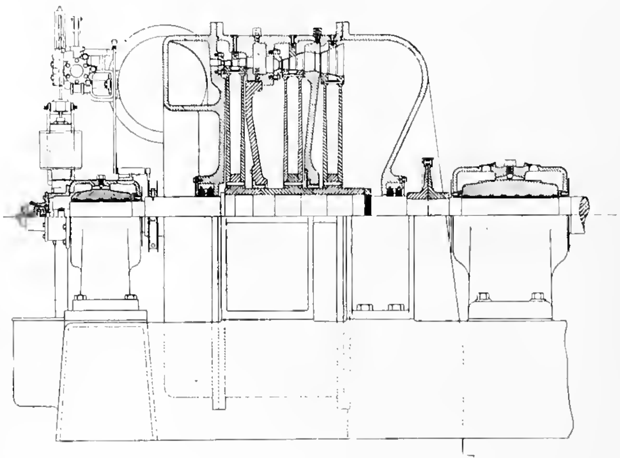
Power output and cost curves indicating increased capacity and economy secured by installing Curtis low pressure turbine sets. Philadelphia Rapid Transit Company, 13th and Mt. Vernon Streets Power Station.

In considering each case in a general way, as outlined, we will suppose in the first instance that one or more engines are already installed and that they all exhaust into a common header, if non-condensing, and into a condenser or condensers, if condensing. The size of the low pressure turbine will be determined by the amount of exhaust steam available and the amount of increased normal capacity desired. The turbine is connected to the common header in the first case and direct to the exhaust in the latter case. Of course, if there is more than one engine furnishing steam to a single turbine, they should be piped to a common header which, in turn, serves the turbine. In each case, a separator should be connected between the source and the turbine to extract the moistur of condensation.

In a case where the generator is to work in parallel with the machine driven by the engine (provided there is a single engine) there need be no governing mechanism. The leads from the low pressure machine may be connected permanently to the leads of the engine driven generator. This is the simplest form of installation and corresponds exactly to the addition of a low pressure cylinder to the engine. Should the load increase, the engine will pass more steam which will tend to speed up the turbine, thus automatically dividing the load. This, of course, is true only with a. c. machines.

This may be, and often is, a case where maximum station economy is a secondary consideration and it might be advisable to run as much steam through the engine as possible without causing excessive strains to the engine.

If peak capacity is desired, it becomes a question as to whether the conditions will require a straight low pressure unit or a mixed pressure which will be capable of operating on overloads on live steam. This, of course, depends upon the amount of exhaust steam available and the amount and duration of overload.



Assembly of 1000 k. w., 1500 r. p. m., low pressure horizontal Curtis steam turbine.

The next case of increasing efficiency without increase of load would mean the selection of a turbine which would give the most economical results at the same time operating the engine at its best economy.

In general, when considering plants such as rolling mills, hoists, etc., where the supply of exhaust steam is intermittent, it will be necessary or advisable to install regenerators into which the extra amount of steam will flow when there is an excess; then, when the amount is too small for the turbine, the regenerator will furnish the necessary amount. If such plants are shut down at times when it is necessary to run the turbine for longer periods than can be taken care of by regenerators, a mixed pressure turbine, or one arranged to use live steam, exhaust steam, or a combination of the two, should be installed.

An interesting installation of the mixed pressure type of turbine is in the Bellingham, Wash., plant of the E. K. Wood Lumber Co., as shown in the first page illustration. The turbine takes steam from a 750 h. p. Tatum & Bowen single cylinder, slide valve engine working non-condensing which has a approximate water rate of from 40 to 45 pounds per h. p. The load on the engine fluctuates from 300 to 900 h. p.

The exhaust turbine receives steam at varying pressures from 1 to 5 lb. gauge. This is possible with

a Curtis machine because the amount of steam admitted may be controlled by hand-valves with cut in or cut out nozzles to the first stage wheels. The customer estimates a saving in first cost due to this installation, over an additional engine unit, of approximately $10,000. The turbine generator is furnishing power to a railroad and carries a varying load of from 100 to 500 k. w.. These results were obtained with no addition to the boiler plant and represent an increase in efficiency of approximately 42 per cent and an increase in normal capacity of 70 per cent.

THE THERMO-ELECTRIC BEHAVIOR OF TANTALUM AND TUNGSTEN.[1]

BY W. W. COBLENTZ.

Tantalum is obtainable in fine wires; it is pliable and does not oxidize readily at ordinary temperatures, and hence suggests itself as a substitute for iron (steel) in connection with constantan wire in thermopiles. The following observations on the thermoelectric behavior of tungsten and tantalum may be of interest. The tantalum wire employed was 25 cm long and 0.048 mm in diameter. It was taken from an unused incandescent lamp. The resistance was 0.85 ohm per cm,

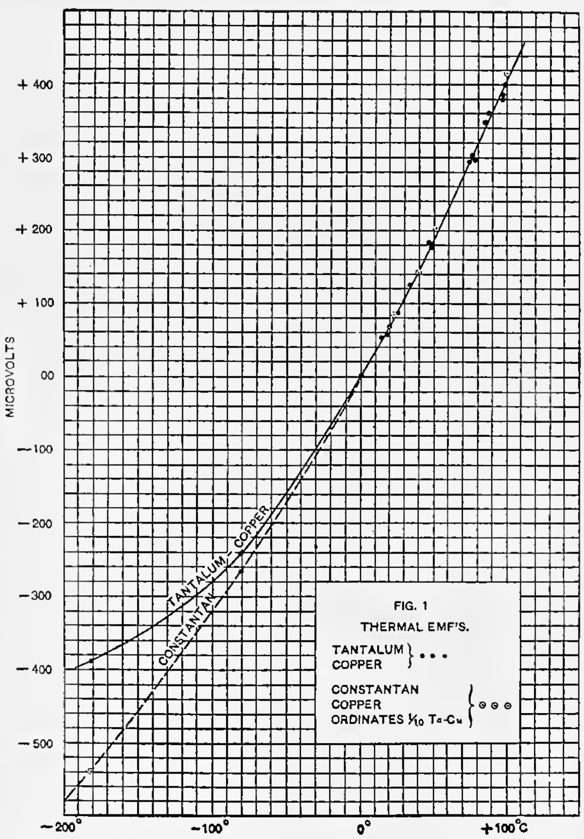


FIG. 1
THERMAL EMF'S.

which was about 0.9 that of a sample of steel wire. The ends of the tantalum wire were wound tightly around copper wires, about 0.1 mm diameter, and then soldered. The copper wires were joined to a potentiometer, by means of a mercury reversing switch, and the comparisons made against a standard cell. Observations were also made on copper constantan and on iron constantan couples made of wires 0.0513 mm in diameter. The temperature was varied from 10 to 100 degrees, and an attempt was made to eliminate the lag of the mercury thermometer. Observations were also made at the temperature of liquid air and of solid carbon dioxide. The results are shown in Fig. 1, in which the black dots indicate the observations on the tantalum-copper couple drawn to scale. The observations at 10, 24, 32, and 47 degrees, respectively, belong to the first series. The observations at 17, 50 degrees, and higher temperatures were made on a new couple and show no marked variation from the preceding. The circles show the observations on the constantan-copper couple, the ordinates (microvolts) being drawn to one-tenth the scale of the tantalum couple.

The results show that throughout the range investigated the thermoelectric power of tantalum (against copper) is about 4.1 microvolts per degree, which is one-tenth that of the copper-constantan couple. The direction of the current is the same as in the copper-constantan couple.

The tungsten wire used in the present experiments was taken from a large "series" lamp. It was about 11 cm long and 0.26 mm diameter. To the ends were wound copper wires 0.1 mm diameter and covered with solder. Tungsten is very brittle, and the sample was

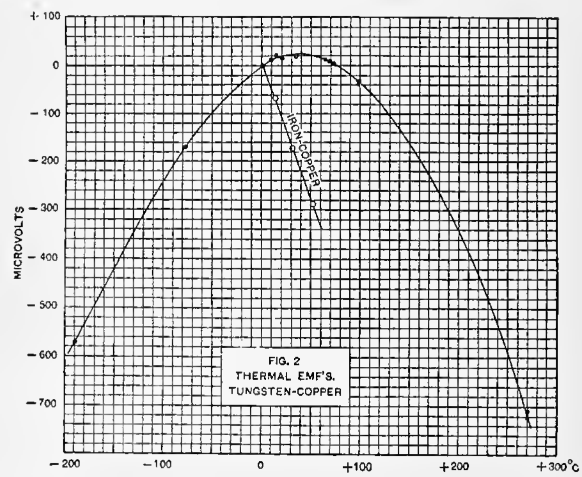


FIG. 2
THERMAL EMF'S.
TUNGSTEN-COPPER

accidentally broken before the observations were completed, so that the observations at 231 and 269 degrees (the freezing points of tin and bismuth, respectively) were made with a length of wire less than 6 cm. long, the copper wires being fused to the tungsten. It was found that this did not affect the results.

The thermal electromotive force curve of tungsten is given in Fig. 2, and is rather unusual in that its inversion temperature occurs at about 40 deg. c. Other combinations, which have an inversion temperature near 0 deg., are cadmium-iron at 170 deg. and copper-zinc at about 30 deg. c. From its appearance it is inferred that the thermoelectric curve is not a true parabola, as was also observed by Dewar and Fleming on numerous other metals. For temperatures below — 100 deg. c. the thermoelectric power (against copper) is about 3.5 to 4 microvolts per degree, while above + 200 deg. c. the thermoelectric power is about 4.5 microvolts per degree, so that tungsten, like tantalum, shows no apparent advantage in thermoelectric work.

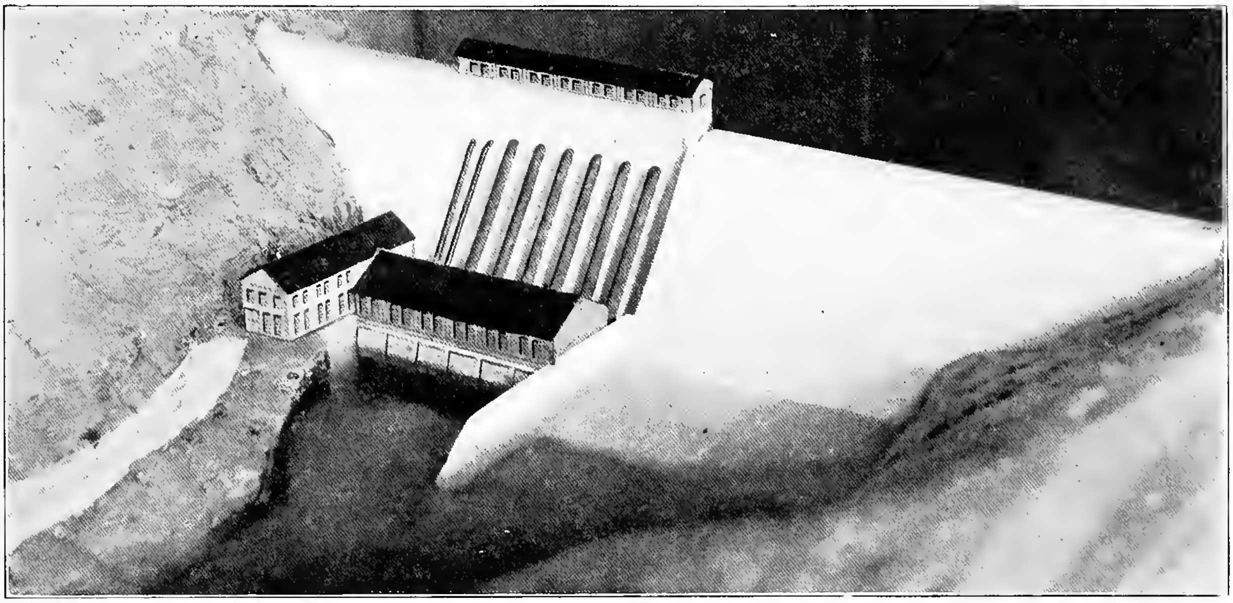
[1]Bulletin of the Bureau of Standards.

THE UPPER CLACKAMAS DAM.

As supplementary to the various articles that have appeared in these columns regarding the system of the Portland Railway, Light & Power Company's system in the vicinity of Portland, Oregon, the accompanying picture of a model of the proposed upper Clackamas development is interesting.

This model was constructed by Sellers & Rippy of Philadelphia, Pa., who are the consulting engineers for the company on this property. The model measures about three feet square and is true to contours and scale and represents very closely the finished appearance of the plant. The development proposed shown by this photograph consists of six 9000 h. p. turbines direct connected to six 5000 kw. generators operating under a normal head of 130 ft. The head available is created by the construction of the dam with the maximum height of 180 ft. The spillway section is 133 ft. high from crest to bucket and when completed we believe it will be the highest spillway dam in the world. During times of maximum flood a depth of 12 ft. of water will be discharged over the crest of the dam.

Preliminary field work has been on the way on this development since 1907, and since June 1, 1908, resident engineers representing the consulting engineers have been located on the property.



Model of Upper Clackamas Dam.

Telephonic delivery of letters has been adopted by the London postoffice to care for those messages mailed too late for delivery on Saturday, and consequently held till Monday. When it is desired to have the contents of the letter telephoned on Sunday it must be inclosed in an envelope addressed to the Central Telegraph Office in London, and a broad line must be marked across the envelope from top to bottom. Postage stamps to the value of three pence (6 cents) for every thirty words must be forwarded.

GOVERNMENT POLICY TOWARD WATER POWER DEVELOPMENT.

Included in the extensive discussion of Henry L. Doherty's paper "Comments on the Development and Operation of Hydroelectric Plants," contributed at the New York meeting of the A. I. E. E. on December 16, 1909, and abstracted in these columns on December 18, 1909, was considerable comment on the attitude of the Federal Government relative to the development of water power. These remarks are here summarized as an expression of engineering opinion on this important question.

H. W. Buck stated that there has been a great deal of literature circulated during the past year which has given false impressions about the fabulous value of water powers as they exist in nature. As a matter of fact, a mountain stream in the wilderness has practically no value whatever in itself. It is only when it is combined with a very large expenditure of money, ranging perhaps from $100 to $200 per horsepower, together with the expenditure of a great deal of brain power in management, financing, and engineering, that this natural geographical situation, called a water power, derives a value. This value is contributed to only in a small degree by the water in its natural state. In this respect the people have a false idea about the value of those properties which the government has lately refused to give over to private enterprise for development.

Furthermore, when a waterpower is developed and is successful, it is profitable only in a reasonable degree. At the present time active competition exists between waterpower and power from various forms of heat engine, and this condition is likely to continue for many years. Even good water powers cannot compete with power generated from steam at low loadfactor in parts of the country where coal costs less than, say, $2.00 per ton. People have been led to believe that a water power is an absolute power monop-

oly, but such we all know is far from the fact. The government also apparently assumes that water powers, will, for all time, continue to be the only source of power. This hardly seems to be justified. The most efficient heat engine today has perhaps a commercial efficiency of 20 per cent, and there is therefore a large margin for possible improvement and economy in this form of engine. A slight improvement would still further increase competition with water power. Furthermore, the energy of waterpower is merely converted energy of the sun. It is quite possible that other means for the utilization of the sun's energy may develop in future generations. The attention of the government is directed toward the preservation of water powers for the sake of posterity. It may be that when posterity arrives the energy of water powers will not be required at all, other sources of energy having superseded its use; and in the meantime the prevention of waterpower development represents a sacrifice for present generations and the loss of a great industrial opportunity.

The government also seems to have adopted a discriminating attitude against water powers as distinguished from other natural resources. Economically there is no difference between a waterpower and any other form of natural resource. It is a situation in nature which can be developed for reasonable profit. So can timber lands, mines, farm lands, and all other property be developed and their potential value liberated for the benefit of mankind; but the agitation against the private development of waterpower as the one natural and injurious monopoly, without reference to all other forms of natural resources seems to be a very one-sided form of socialism and an unjust discrimination against those who are interested in the development of waterpower.

H. A. Storrs wrote that Mr. Doherty's comments must appeal to all engineers in the West, who are in a position to know the effect of the present conservation movement on hydroelectric enterprises. His remarks are specially opportune just now, when the government, through its officials, is calling for legislation and shaping policies looking to better control of our natural resources. It is true that in the past the government's efforts to exercise control over waterpower developments have been "largely misdirected or very generally misunderstood." Especially does this seem to be the case from the point of view of those who have found the former untrammelled conditions conducive to large gains on small speculative investments. It is not so much a matter of inducing public officials to take the "proper attitude" toward the development of our water powers, as of bringing about proper legislation to enable public officials to have some definite basis of authority on which to act. Our government officers, if given definite, comprehensive laws under which to work, and sufficient funds to enable them to perform the required work, can furnish a basis for future development of the waterpower possibilities of the country that will give a stability to hydroelectric enterprises not possible under the present chaotic conditions.

Referring to Mr. Doherty's statement to the effect that the efforts of the government to exercise some control over waterpower developments seem to be obstructing rather than encouraging such enterprises, the particular case presented below will serve to show what results may be expected if the present government policy is enforced. The National government cannot, however, under the present laws, exercise general control over the waters of non-navigable streams, since this authority is vested in the separate States. But, under the Act of June 4, 1897, the Secretary of Agriculture has full power to regulate the occupancy and use of the natural forests. Through the Forestry Service, therefore, the government deals with prospective power plants, storage reservoirs, conduits and transmission lines, so far as they may be located within the limits of the forest reserves. The essential features of the government's policy as stated recently by the chief forester in a letter published in The Outlook, December 4, 1909, are: first, that the right to develop waterpower on the forest reserves shall be granted for a limited term of years and not for all time; secondly, that a reasonable charge shall be made for the privilege granted. The application of these principles is illustrated by the following case.

Under date of November 24, 1909, permission was granted by the Forestry Service, covering the occupancy and use of certain lands in one of the national forests in Colorado, for the storage reservoir of a power generating plant. The principal features of the terms under which the permit was granted are as follows:

1. Payment to the United States, annually in advance from September 1, 1909, until the beginning of use of the waters for which permit is granted, at the approximate rate of one dollar per acre of reservoir area and five dollars per mile of conduit for the land occupied by such works.

2. Payment to the United States of a gross operating charge, based on the total electrical output of the plant per year, at the following rates per 1000 kilowatt-hours:

For the 1st year	2 cents
" " 2d "	4 "
" " 3d "	6 "
" " 4th "	8 "
" " 5th "	10 "
" " 6th to 10th years inclusive	12½ "
" " 11th " 15th " "	15 "
" " 16th " 20th " "	17½ "
" " 21st " 25th " "	20 "
" " 26th " 30th " "	22½ "
" " 31st " 35th " "	25 "
" " 36th " 40th " "	27½ "
" " 41st " 45th " "	30 "
" " 46th " 50th " "	32½ "

Certain deductions are allowed from the "gross" charge in case: (a), the title to part of the watershed has passed out of the United States; (b), the conduit is not wholly on government lands; (c), the power is derived in part from water stored in a reservoir constructed or owned by the permittee.

The following table shows the gross charges as determined for the project under consideration:

TABLE I.

Year	Output: Average kilowatt per day	Output: Average kilowatt hours per day	Output: 1,000 kilowatt hours per year	Rate per 1,000 kilowatt hours	Annual charge
1912	3,000	72,000	26,000	2 cts.	$525.60
1913	5,000	120,000	43,800	4 cts.	1,752.00
1914	7,000	168,000	61,320	6 cts.	3,679.20
1915	10,000	240,000	87,600	8 cts.	7,008.00
1916	12,000	288,000	105,120	10 cts.	10,512.00
1917 to 1921	12,000	288,000	105,120	12.5 cts.	13,140.00
1922 to 1926	12,000	288,000	105,120	15 cts.	15,768.00
1927 to 1931	12,000	288,000	105,120	17.5 cts.	18,396.00
1932 to 1936	12,000	288,000	105,120	20 cts.	21,024.00
1937 to 1941	12,000	288,000	105,120	22.5 cts.	23,652.00
1942 to 1946	12,000	288,000	105,120	25 cts.	26,280.00
1947 to 1951	12,000	288,000	105,120	27.5 cts.	28,908.00
1952 to 1956	12,000	288,000	105,120	30 cts.	31,536.00
1957 to 1961	12,000	288,000	105.120	32.5 cts.	34,164.00

3. Payment for all timber destroyed in the forest reserve.

4. Construction of the works to begin within 18 months from date of approval of the permit; construction to be completed and operation of the works for the purpose intended to begin within 3 years from date of approval of permit.

5. The United States reserves, conditionally, the right to purchase power at as low a price as that allowed to any other purchaser.

6. The permit is not transferrable.

7. The permit shall be forfeited to the United States, if the works be controlled by an unlawful trust, or if they be used in restraint of trade in the sale of electric energy.

8. The permit shall cease and be void at the end of 50 years but is renewable upon conditions not yet fixed.

For the purpose of comparing the government charge to be paid for the waterpower privilege with the annual income of the plant, the following table has been prepared showing what per cent of total gross receipts must be paid to the government:

TABLE II.

RATIO (IN PER CENT) OF GROSS ANNUAL CHARGE TO GROSS ANNUAL INCOME.

	Sale price of delivered power per kilowatt-hour. 1c.	2c.	3c.	4c.	5c.
1912	0.2	0.1	0.07	0.05	0.04
1913	0.4	0.2	0.13	0.10	0.08
1914	0.6	0.3	0.2	0.15	0.12
1915	0.8	0.4	0.27	0.20	0.15
1916	1.0	0.5	0.33	0.25	0.20
1917 to 1921	1.25	0.625	0.42	0.31	0.25
1922 to 1926	1.5	0.75	0.5	0.38	0.30
1927 to 1931	1.75	0.875	0.58	0.44	0.35
1932 to 1936	2.0	1.0	0.67	0.50	0.40
1937 to 1941	2.25	1.125	0.75	0.56	0.45
1942 to 1946	2.5	1.25	0.83	0.63	0.50
1947 to 1951	2.75	1.375	0.92	0.69	0.55
1952 to 1956	3.0	1.5	1.0	0.75	0.60
1957 to 1961	3.25	1.625	1.08	0.81	0.65
Average......	2.085	1.0425	0.695	0.52	0.417

The table shows that for the 50-year period the average payment to the government is about 2 per cent of the gross receipts, at a sale price or valuation of 1 cent for each kilowatt-hour, delivered by the plant, and about 1 per cent at a valuation of 2 cents per kilowatt-hour.

Applying these figures to the case in hand, assuming the average value of the electric power during the 50-year period to be 1 cent per kilowatt-hour, the gross annual receipts would be about $1,000,000 and the average annual payment to the United States would be $20,000.

In response to inquiry, asking what privileges and benefits were secured by paying to the United States the above "conservation" charge, the Forest Service replied as follows:

"The conservation charge is based on the value of the land occupied for the particular use to which the land is to be put, and on the special benefits the permittee received by reason of the care and administration of the natural forest including the protection of the watershed from fire and destructive cutting which materially affect the water sources."

The permit in hand was secured for the benefit of a project comprising a storage reservoir of 10,000 acres superficial area, of which 260 acres only were within the boundaries of a forest reserve. It follows that the annual payment of $1.00 per acre for the three years allowed for construction amounts, in this case, to only $260; whereas, if the entire reservoir had been in the reserve, a payment of $10,000 per year would have been required. It is presumed that the object of this heavy initial tax on the enterprise is to compel immediate construction of the works, thus preventing the power possibility from being held, undeveloped, for speculative purposes. Speculation in undeveloped water powers on forest reserves is still further guarded against by making the permits non-transferrable.

The recommendations of the Secretary of the Interior, in his recent annual report, are generally in line with the present practice of the Forest Service, except that he would limit the life of the permit, or "easement," to 30 years, allow four years for accomplishing the first quarter of the proposed development, and require that transfer be made to the United States of the water rights necessary to provide for the estimated power development.

In view of the probability that, during the next decade electrical power will be applied extensively to the operation of railroads in the West, the policy and methods of the government in exercising control over water powers located on government lands are subjects of great practical moment to the country at large. They deserve the careful consideration of engineers who are in a position to influence the trend of legistion and of public opinion.

O. S. Lyford, Jr., speaking of a similar permit, stated that the tax, if the drainage area and hydraulic conduit were entirely on forest reserve, and if the entire estimated power were marketed, would amount to about $350 for the first year and $5600 for the 50th year. The estimated annual operating cost of the total output of the plant including fixed charges is $180,000. Therefore, in such a case an hydroelectric development entirely on forest reserve would, under these terms, be subjected to a tax of from 0.2 per cent to 3.1 per cent of the total annual operating cost. The charge during the first year is not considerable. Whether the charge for the later years will prove reasonable will depend on the taxes and other burdens which may be imposed on the power company by the State.

The principal burden placed upon the power company under this permit is the 50-year limitation, with no definite assurance that the improvements made by the company will not in effect be confiscated at the end of the period by refusal to renew.

GOVERNMENT SPECIFICATIONS FOR ELECTRICAL APPARATUS.[1]

BY CHAS. F. SCOTT.

The story of the Atbara Bridge, which an American firm proposed to erect and actually did erect in less time than foreign manufacturers required for the completion of their drawings, is an international example of the American use of standards. The specifications called for the erection of a bridge of definite capacity, without including detail particulars. Had they not been broad enough to admit the American standards, the American bidders would have been excluded, or rather new designs, special materials and long delay would have been involved. We all know that American manufacturing has won its success because things are made in large quantities in standard sizes. It is reasonable, therefore, to expect that the policy of the American government would be to follow the American method, by putting a premium upon standards and standard specifications. The government, as a large purchaser, should be the last to create a demoralizing interference in industrial methods by calling for things which are not standard, but involve special requirements and distinctions, often of little or no vital consequence. And yet cases may be cited in which the course pursued by the government has fostered specialization and irregularity, often involving complication and higher prices with no compensating advantages.

As an instance of an extreme condition, and the way in which it was remedied, I cite the following statement which has been given me regarding incandescent lamps.

When the question of purchasing incandescent lamps in large quantities for the several departments of the government was taken up and investigated about five years ago, it was found that the Treasury Department had one specification; the Bureau of Yards and Docks of the Navy another; the Bureau of Equipment of the Navy a third; the Quartermaster's Department a fourth; the Library of Congress a fifth; the government printing office a sixth; the Post Office Department a seventh, and the Bureau of Engraving and Printing an eighth. While nearly all of the lamps were substantially the same and there were but few unusual requirements, yet no two of these specifications agreed and great difficulty was experienced by the manufacturers in understanding just what type of lamps should be furnished under any one of them. To eliminate this difficulty the Bureau of Standards and the government engineers of the several departments held a meeting in Washington to discuss the subject of standardization of specifications and appointed a committee which met with a similar committee appointed by the incandescent lamp manufacturers. This joint committee drafted what is known as the government standard specification and today when one department of the government requests proposals on standard specifications, they are the same as the specifications of any other department, excepting in isolated cases, for example, the Navy Department which requires some special lamps. The standard specifications have eliminated a great deal of difficulty on the part of the lamp manufacturers and the government engineers as well.

A further illustration of the same kind is afforded by rubber insulated wire. In this case, however, I am informed that the work has not yet been carried to completion. On the investigation of the specification for standard rubber covered wire, it was found that the Navy Department's Bureau of Equipment had one specification, the Navy Department's Bureau of Yards and Docks another, the Library of Congress another, the Treasury Department another, the Quartermaster's Department another, and there were perhaps one or two other peculiar specifications. On looking over these specifications, they ran a complete line from the poorest competition wire which would comply with the National Board of Fire Underwriters' manufacturing specifications, to the most elaborate specifications for 36 per cent Para rubber insulation; notwithstanding the fact that the wire was to be used under virtually identical conditions. In investigating this matter the question of wire for ship-board purposes was taken into consideration and it was found that with few exceptions, all specifications for wire could be embodied under a few general heads.

A further instance which has been cited in the same connection is with regard to motors. When the question of specifications for motors was looked into, it was found that the same variance takes place in the specifications: For example, the temperature requirements of a motor covered the entire line from operation at full-load for an hour with a rise of 75 degrees F., to operation continuously for 24 hours at 25 per cent overload with a considerably less rise of only 63 degrees F. Such variance in the requirements for motors would apparently cause the manufacturer to make up special apparatus to comply with each specification.

As an example of the non-conformity of specifications and lack of co-operation, it may be cited that in one instance three bureaus were represented in the specifications for apparatus which was to be operated in conjunction, and in which controlling panels for various motors were to be installed in a single room or compartment. One of the bureaus specified a water-tight control panel; another, a switchboard enclosed in a non-water-tight sheet iron case, and the third entirely open panels. Three types of control apparatus were, therefore, to be installed in conjunction, in the same compartment.

It is easy to criticise and to show the absurdities in such divergence in specifications as are afforded by the foregoing instances. They certainly are not the result of any established policy, but are examples of certain practices which have grown up under past conditions. In discussing the subject, there are several features which should be considered:

1—The government as a purchaser has, in many cases, prepared its specifications before suitable commercial standards were established and recognized. This was undoubtedly the case as regards lamps and

[1]A paper delivered at the U. S. Engineer School, Washington Barracks, Washington, D. C., December 15, 1909, and printed in the Electric Journal.

wire. In the matter of rubber covered wire, for example, one of the largest electrical manufacturing companies, which is an extensive user of such wire, found a few years ago such chaos in wire specifications and such divergence among the regular products of different wire manufacturers, that it was compelled to make its own purchasing department specifications for rubber covered wire. This was not done in an arbitrary way, but by considering carefully the various standard makes and after consultation with the various manufacturers, a standard list was prepared which would meet the requirements and would impose a minimum inconvenience upon those who furnished the wire. Obviously, it is impossible for the government to use standard specifications if there are no standards.

2—Another reason why government specifications are apt to appear arbitrary and call for special apparatus is due to the tendency to enter into particulars and to do designing. It is hard for the engineer, government or other, to restrict himself to general requirements and not yield to the temptation to enter into details which should concern only the designer of the apparatus. Ordinarily, the purchaser should not be the designer; or if he is, he must take the consequences in restricting competition, in uncertain deliveries, in the extra cost which such products usually involve and he should properly share the responsibility for what he designs.

3—Apparatus may be specified to meet exactly certain definite requirements, although it may be entirely feasible to adapt or modify the conditions so that standard commercial apparatus may be used. For example, in designing a mechanical structure, it may be calculated that an I-beam of certain dimensions will exactly meet the requirements. If these are different from those of standard sizes, its manufacture would involve delay, inconvenience and extra cost. On the other hand, the use of a standard I-beam would probably require only slight modifications in the conditions, or in the arrangement of other parts. Likewise, in arranging machines to be operated by a motor, it may be found that some odd horsepower at some unusual speed, or certain special forms or dimensions of bed plate or bearings happen to meet the exact requirements, whereas, some slight modification in the arrangement might enable a standard motor to be employed. In some instances this cannot be done, as new requirements justify special construction, but such cases are the exception. A demand for something special, when that which is standard might be used, shows inferior rather than high engineering ability. The best engineer seeks to adapt his conditions so that he may utilize the things at hand, the standard products which are upon the market.

4—Some of the men who are called upon to prepare specifications have been trained in government schools, and in government service, and have never had experience in manufacturing or commercial work, and hence they often do not have a first-hand technical and practical knowledge of the matters involved. Men who have not had a commercial training may not have developed the instincts of economy of the ordinary commercial engineer, and are more apt to yield to the temptation to specify what they want, regardless of what is available and regardless of cost.

5—Another alleged reason why government specifications have not conformed to ordinary practice is that the government officials are in a position of authority and are sometimes arbitrary, unyielding and apt to be controlled by technicalities. It is quite likely, on the other hand, that government officials have regarded the manufacturers as inordinately commercial, putting their individual interests far above engineering excellence or government efficiency. But whatever weight such consideration may have, it does not fall within the range of the present discussion to enter into personal criticism.

Some of the results of arbitrary action, however, both in the issuing of specifications and in the acceptance tests of apparatus, react upon the government, and place it at a commercial disadvantage. Apparatus will cost more if, when inspected and tested, it is liable to be rejected on technicalities, for the manufacturer must charge extra to cover this liability, and in the long run manufacturers may decline to bid, thereby reducing competition. Much depends upon the spirit in which the specifications are interpreted. An ordinary business man, particularly when he asks for something in which the conditions are new, is satisfied if the specifications are approximated within a certain reasonable range, particularly if the essential and useful elements are satisfactory, and the apparatus accomplishes its purpose. But the government inspector has the reputation of demanding his "pound of flesh." As an example, a machine adapted for both alternating and direct current was sold to the government. It was intended to state in the specification that the alternating current voltage should be "approximately 70 per cent" of the direct current voltage, but a typographical error made the figure 73 per cent. The machine was not acceptable because the actual ratio was about 70 per cent. It was a matter impracticable to change on account of certain inherent elements depending on the arrangement of the windings and the width of the field poles, which proportions were selected in order to secure the best commutation and the best general performance of the machine. In this case, a general approximate descriptive statement (which was a typographical error) was interpreted as a rigid guarantee, and a variation from it was treated as if it were as serious as a failure of several per cent in efficiency. The operating excellence and adequacy of the machines were not questioned, but the miserable little matter of ratio caused long drawn-out annoyance, friction and delayed payments.

In another case, certain small generators were supplied for shipboard operation, which on test were found to have a temperature rise which exceeded the specified limit by a few degrees. The apparatus, if rejected, would be of little or no value to the builder, as it was special. The outfits were eminently satisfactory, except in the trifling excess temperature. The inspector who made the test reported that they were the best machines he had ever seen, and were satisfactory, except in the one point of temperature. The actual temperature rise was a trifle more than the government specification, but was less than ordinary

commercial standard practice. The "pound of flesh" was exacted in the form of a penalty equal to nearly one-half the value of the generators, which turned a manufacturer's small profit into a large loss. The result was that the manufacturing firm which had thus been penalized has declined to make further bids when importuned to do so by this Bureau.

In a certain specification for a machine for a special service, the specification contained a clause the meaning of which was not clear. Literally, it either meant nothing or specified a physical impossibility. A more liberal interpretation indicated a desirable and proper characteristic. The designer took the commonsense interpretation and did what was practical and useful. The machine met its acceptance test satisfactorily, except that it did not literally comply with the impossible requirements. The inspector declined to accept the machine. The matter was investigated. It was found that the original writer of the specification did not know what the particular paragraph meant, but he had seen an attractive phrase somewhere and had incorporated it. The machine was finally accepted, but the conference between the inspector and his superiors had caused a delay in shipment and for this a penalty was incurred, which the manufacturing company had to pay.

It is easy to criticise specifications and tests and to cite past specific experiences as horrible examples of how things should not be done. It is also easy to demonstrate the value of standard specifications. It is quite another matter to prepare ideal specifications. This is especially true of electrical apparatus where there must be constant evolution and development to keep up with increasing requirements and improvements in design. Commercial specification should form a definite basis for present work, but they should not restrict progress.

The whole matter of specifications for the purchase of material and apparatus is a complicated one. There are two sides to it, one concerning the user, the other concerning the manufacturer: first, what is necessary to perform the required service, and, second, what is commercially or practically available. The company with which I am connected is a large purchaser of materials. Many of these are ordinary commercial products; others involve special requirements on account of the uses to which they are put. We do not arbitrarily specify what we would like to have, but we consult freely with the manufacturers to determine how our needs can be best met by what they are in position to furnish. We recognize that we are not experts in their products and we enter into conference with them, and in many cases results have been secured through conference and co-operation which could not otherwise have been attained. In a few cases, we have been accused of having scientific experts, who do not know the practical uses and essential qualities of the material, write up the specifications, using various scientific terms and proposing theoretical and scientific tests. Such a specification is usually modified by conference. Our real aim, however, is to write specifications which will provide a reasonable, practical measure of the ability of the material to meet the requirements for which it is to be used.

A number of years ago, the American Institute of Electrical Engineers recognized a confusion among manufacturers, consulting engineers and users, which arose from imperfect standards. There was a topical discussion on the standardizing of generators and transformers at a meeting in January, 1898.

It was pointed out that while it would probably be impracticable to establish definite sizes or lines of apparatus that would be satisfactory to all concerned and it should not be the object of the Institute to introduce standards which the evolution of business would soon render useless, yet there were certain features which could properly be taken up by the Institute, notably the definitions of terms used in specifications, uniform methods of rating apparatus, methods of conducting tests, etc. A committee was appointed and its report was issued in June, 1898. This report has been revised twice and was issued in its present form in June, 1907, as the "Standardization Rules of the American Institute of Electrical Engineers." Various matters relating to definitions of terms, performance specifications and tests, which may be adopted in general practice for making definite and uniform the specifications between manufacturers and purchasers, are presented in a simple, practical way. No attempt is made to dictate sizes, speeds, dimensions, and the like. The aim is to define what a specified load really means and how it should be measured; what elements are involved in efficiency and how they should be measured; what constitutes a reasonable rise in temperature and how temperature should be measured. These standardization rules have been proposed and revised by a large representative committee, including experts connected with government bureaus, engineers from manufacturing companies, consulting and operating engineers and scientific experts. The rules have been submitted in preliminary form to expert engineers for criticism and suggestion. They, therefore, represent the best practice. The rules do not purport to be scientifically abstruse, nor to cover all cases; for example, in connection with definitions, this note is given: "The following definitions and classifications are intended to be practically descriptive and not scientifically rigid"; and in connection with insulation tests: "The voltage and other conditions of test which are recommended, have been determined as reasonable and proper for the great majority of cases, and are proposed for general adaptation, except where specific reasons make a modification desirable." It is common practice in commercial specifications and tests to follow methods laid down in these standardization rules. Incidentally, they are quite comprehensive in their scope and bring together in concise form a very large amount of engineering data and information. One man who read through the rules carefully remarked that he felt that he had reviewed his whole college course.

Electric Motor Specifications.

An admirable presentation of the elements which should enter into a commercial specification is contained in a paper presented to the American Association of Electric Motor Manufacturers by Mr. R. S. Feicht, chairman of its committee on government specifications, in May, 1909. The subject is so well discussed that I shall quote at length from the paper.

The purpose of motor specifications for large consumers is:

1—To insure a uniform grade of apparatus of a satisfactory quality and performance.

2—To enable the purchasing department to place orders for motors without the necessity of securing special engineering advice and with the assurance that the proper motors will be obtained for the particular applications involved.

With these points in mind, let us see whether we can establish some of the important characteristics of an ideal set of motor specifications.

1—They should be written in a clear concise manner so that there can be but one interpretation for each statement and no two parts should be in any way contradictory. These are particularly vital points as the specifications are made up for the use of the motor manufacturer and the representative of the customer, who are usually not consulted in writing the specifications, and, therefore, are not familiar with the intent of the specifications unless the wording of them is unmistakable.

The use of such phases as "perfect mechanical balance," "without sparking," and "satisfactory operation" should be carefully avoided as a literal interpretation of them may cause the rejection of any machine however well designated and constructed. Perfect mechanical balance is attained by accident only. Absolutely sparkless commutation is practically impossible. Satisfactory operation depends entirely upon how easily the witness may be satisfied. It is not right that a manufacturer should be put to the expense of building a motor, the acceptance of which is entirely dependent upon the personal equation of a witness. The wording of the specifications should be such that the manufacturer will be in a position to know positively before the witness test is made that the motor will or will not meet the specifications in every particular.

2—Ideal specifications should contain a general description which will permit the use of any well recognized standard apparatus for the purpose, thereby insuring competition in bids. They should be broad and liberal so as to permit the usual variations in design. It should be recognized by the writer of the specifications that the future development of the motor depends upon variations in the present designs and, therefore, unnecessary restrictions, which serve no good purpose but simply throttle development, should be avoided.

3—Ideal specifications should either omit performance guarantees altogether and leave them to the bidder to supply, or should give them slightly lower than the average, preference being given in the awarding of the contract to motors with the highest performances, other things being equal.

4—Ideal specifications should cover the tests which are to be made to determine whether the motor meets guarantees and, recognizing the unavoidable variations in workmanship and materials and with what degree of accuracy the tests can be made in a commercial testing room, they should specify within what limits the results of tests are to be considered as meeting guarantees.

We often find in specifications for motors that certain points are covered which should obviously be omitted. In the following a few of these points are noted:

Certain characteristics of a motor are at times specified which in themselves are of no particular moment, but which affect other characteristics covered by the guarantees. In other words, the end is specified in the guarantees and in addition the means of attaining the end are covered by general requirements. As an example of this feature, we often find in specifications that temperature guarantees are specified for full-load and over-load and in addition the question of ventilation is covered. Now, if the temperature guarantees are met, the question of inherent ventilating characteristics is of no importance whatever to the customer. Again some specifications cover efficiency guarantees very minutely and in addition specify that the losses in the motor shall be a minimum or that the best grade of iron shall be used to minimize the losses, etc. Here, also, if the efficiency guarantees are met, the question of losses and quality of material used are irrelevant and serve only to handicap the designer.

Some specifications, though apparently written on a liberal and unprejudiced basis, distinctly discriminate against certain designs of apparatus or against apparatus manufactured by certain companies. This practice, of course, should not be countenanced unless the particular design discriminated against is one which is not considered a recognized standard.

Some specifications cover methods of testing which are not considered accepted standards and which, therefore, involve the manufacturer in unnecessary expense in preparing for witness tests.

The principal defect of the present government specifications is that they do not, in the majority of cases, permit the use of standard apparatus which has proven satisfactory to the general trade. It is inconceivable that the requirements of the government should be such that it is necessary for manufacturers to build a special line of motors for its use. We do not believe that any such necessity really exists, excepting for apparatus to be used in the equipment of war vessels. In this paper, we are not referring to this class of apparatus, but simply to that which is used by the government for land service in applications similar in all respects to that of ordinary users.

The types, classifications, and nomenclature of the present specifications differ from those of the A. I. E. E. and A. A. E. M. M. which we now consider recognized standards.

The most elaborate witness tests are specified to be made at the expense of the manufacturer. We see no reasonable excuse for the government requiring more elaborate tests than are required by other users, nor can we see any necessity for witness tests being specified for all motors.

We see no reason for the government specifications not being of such a character that they may be used by the small consumer and public in general, as guides in the purchase of motors without the fear that unnecessary special features will be involved, which will interfere with prompt deliveries and increase the cost over that of standard apparatus.

The frequency with which government specifications are issued is one of the greatest objections to them. The present specifications have been in force less than a year when completely new ones are proposed. Since January, 1902, four sets of specifications have appeared, making an average of one in about every twenty-two months. If these specifications are made up properly, they should hold for a much longer period unchanged, and, with slight changes and additions to keep pace with the development of the apparatus covered by them, they should remain in force indefinitely. It is practically impossible for a motor manufacturer to change designs of motors as rapidly as the government specifications have been changed without serious losses from apparatus rendered obsolete, and it is, therefore, very desirable that the new specifications be made to agree with the most modern practice and that changes in them thereafter excepting for good cause be discouraged.

As indicated, the paper from which the foregoing extracts are taken was presented before the American Association of Electric Motor Manufacturers, an association which is accomplishing some highly satisfactory results. Its methods may be taken as a good example of the right way to do things. The manufacturers have gotten together with a view of standardizing their products. By invitation of the Bureau of Construction and Repair of the Navy Department a con-

ference was held in Washington on May 28 and 29, 1909, at which were represented six bureaus and nine motor manufacturers, a total of twenty-eight men. Preliminary specifications had been issued by the government engineers; these were freely discussed, paragraph by paragraph. A final specification has since been issued substantially agreed upon and practically conforming to the rules and recommendations of the A. A. E. M. M. These specifications apply to all departments of the Navy Yards and Stations and are suitable either for the government or the public. They were issued after Mr. Feicht presented his paper; hence his criticisms were directed at the earlier specifications and not those now in force.

After the conference Electrical Expert Aide, M. W. Buchanan of the Bureau of Construction and Repair of the Navy, made the following statement with regard to the way in which the work had been done:

"The valuable discussions on points where opinions diverged and the interest maintained throughout a rather long and tiresome conference, also the cheerful spirit which obtained under trying conditions, were all the subject of very favorable comment by the officers of the Bureau."

Obviously, it should be unnecessary for each of half a dozen or more bureaus and departments to prepare its own specifications for the same thing. There should either be a conference between departments, or some one department should prepare the specifications. While this could not be carried beyond certain limits, there is a very large list of ordinary standard productions, the specifications for which could be satisfactorily prepared in this way. This method has been carried out by the Bureau of Standards with respect to incandescent lamp specifications and electrical measuring instruments, and specifications are now being prepared for transformers after consultation with representatives of the governmental departments and several manufacturers. This is certainly a logical and sensible method and is capable of great benefits to the government.

Standard government specifications, prepared in conference with the manufacturers, including tests which will determine the practical utility of the apparatus, and acceptable both to the government and to the manufacturers, will not only benefit both parties, but will be accepted by the public. Therefore, the government, instead of being a disturbing element in industrial manufacture, may become a useful instrument in establishing standard commercial specifications which will be a great aid in standardizing American products. Both the general public and the manufacturers would welcome such specifications, assigning to them the weight which should properly be attached to engineering work of the government.

There has been very substantial progress away from the conditions which are exemplified in some of the instances of unsatisfactory specifications and tests which have been cited. There is a change from the old-time attitude, in which the government in an ill-advised or arbitrary way, gave little consideration to commercial standards and methods, and, on the other hand, in which commercial interests looked upon the government as a legitimate field for the sale of poor apparatus at high prices. There is a growing disposition within the government bureaus to work together in engineering matters along the lines which modern business development has shown to be the most efficient. There is every reason why harmony and co-operation between departments and between the government and commercial interests should lead to mutual advantage. The government should foster the best industrial methods and practices. The engineering and commercial interests of the country should take a pride in government work—the government is theirs and they should, with a broad patriotic spirit, take pride in the excellence and economy with which its engineering functions are performed.

REPORT OF WISCONSIN COMMITTEE ON WATER POWER.

The report of two members of the special legislative committee on water powers, forestry and drainage, Senators Paul Husting and Henry Krumrey, just made, shows that the amount of horespower available on the twelve principal streams of the State of Wisconsin, namely, the Wisconsin, Fox, Wolf, Chippewa, Black, Menomonie, Peshtigo, Oconto, St. Croix, Rock, Flambeau and Milwaukee rivers is 827,900 horsepower, and of this amount 183,105 horsepower has been developed.

The committee recommends the levying of ten per cent on the annual franchise value per horsepower. By annual franchise value is meant the difference in cost between the production of power by waterpower and the production of power by coal at the same place in like quantities and under like circumstances. It was also recommended that the State should fix the location, height, and general construction of the dam in order that the power may be developed to the highest potential efficiency, and that provisions should be made to prevent monopolization of power.

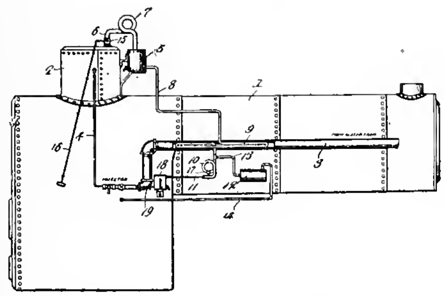
UNDERGROUND ELECTRIC RAILWAY YARD.

Blasted out of solid rock, two miles underground, in the heart of a mountain near Mullan, Idaho, is a fully equipped railroad yard with electrically propelled cars handling the rich lead-silver ore produced by the Morning mine, owned by the Federal Mining and Smelting Company. The work, which has just been completed under the direction of Charles K. Cartwright, required more than a year and and involved the expenditure of several hundred thousand dollars and the labor of many men.

The yard, which is the only one of its kind in the Northwest, and is believed to be the largest underground mine yard in America, is 200 feet in length and 36 feet in width, the height ranging from 20 to 100 feet. The electrical apparatus and hoisting machinery are in a chamber, 50 by 78 feet and 20 feet high, while in the rear of the four-compartment shaft, now under construction, is an ore bin, 20 by 26 feet and 50 feet high, with a capacity of 1,500 tons. The shaft will be sunk to reach a depth of 2,600 feet.

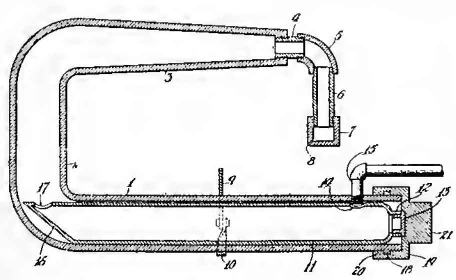
PATENTS

948,881. **Means for Preventing Boiler Explosions.** Julius V. Hoffmann, Jasper, Ind. In means for preventing explosion of steam boilers, a pipe having connection with the highest point of the steam boiler so as to carry off the dry steam or



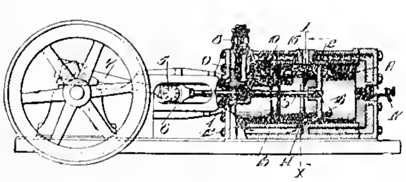
gases, a second pipe of less diameter than the first mentioned pipe and connected therewith, and a third pipe of less diameter than the second pipe and having connection therewith and with the water supply pipe.

948,921. **Oil Burner.** William H. Creswell, Los Angeles, Cal. An oil burner comprising a U-shaped body portion having a lower horizontal arm, an upper horizontal arm, and a vertical arm connecting the lower and upper arms, said arms



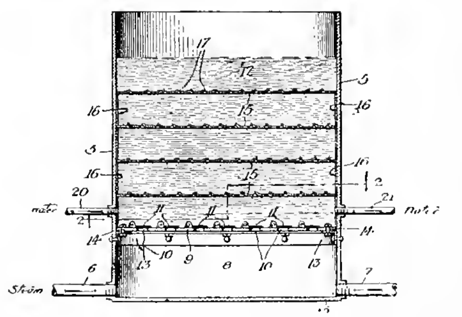
being formed of a single casting, a short pipe depending from the upper arm and provided with a nozzle to project the flame toward the lower arm of the body portion, and means for admitting oil to the lower arm of the body portion.

948,860. **Two Cycle Gas Engine.** John M. Johnson, Alfred C. Johnson and August Johnson, Sunnyvale, Cal. In an engine of the character described, the combination of a cylinder closed at both ends, a piston adapted to reciprocate in said cylinder, a piston rod extending through the outer ends of the cylinder, a crank shaft to which the outer end of said rod is



connected, an inlet valve at one end of the cylinder, said cylinder having a passage at one end connecting with said valve and adapted to admit an explosive mixture to the outer portion of the cylinder, a pipe extending substantially parallel with the axis of the cylinder having one end connecting with said inlet passage and the other end leading toward the piston, said cylinder having its compression chamber formed between the piston and the end of the cylinder containing said passage and into which chamber said pipe leads, whereby the charge of cool gas and air forming the explosive mixture is delivered against the piston and acts to partially cool and reduce the temperature thereof, a supplementary passage and ports through which the charge is admitted from the compression chamber to the working end of the cylinder, said port being controlled by the operation of said piston.

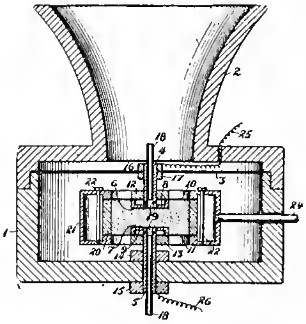
948,432. **Condenser.** Elmer F. Rudeen, Los Angeles, Cal. A steam condenser, comprising a tank, a head in the tank introducing steam and air to the lower compartment, means of



dividing it into upper and lower compartments, means for introducing and withdrawing water to and from the upper compartment, there being communication between the upper and lower compartments for the passage of the steam and air.

948,833. **Composition for Cleaning Boilers.** Eugene Vezie, Washington, Pa. A composition for preventing and removing incrustations in boilers and the like, consisting of coffee, tobacco, balsam weed, Epsom salts, yarrow and pulverized graphite.

948,609. **Wireless Telephone Transmitter.** Albert A. Jahnke, San Francisco, Cal., assignor of one-half to Susan C. Tate, San Francisco, Cal. A telephone transmitter having a



chamber, end walls of which are formed by vibrating diaphragms, and having an annular porous wall, granular material in said chamber, and a chamber surrounding said porous wall and adapted to contain a volatile liquid.

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CONTENTS

Standardization

The success of American manufacturers depends mainly upon manufacturing in large quantities in standard sizes. This applies as well to I-beams as to watches. In like manner much money is annually lost in making special designs for special purposes, when by a slight change standard equipment could be adopted. According to George Westinghouse, the high cost of manufacturing is largely due to a dearth of uniform standards. In addressing a body of Boston engineers he recently stated that there are probably fifty thousand needless variations in electric motors which have added many millions of dollars to the investment in electric installations. Each maker has his own patterns and designs, one large manufacturer having over ten thousand regular motors available. Yet within a year he had requests for ten thousand more special designs not in stock. This chaotic state of affairs Mr. Westinghouse attributes to that unregulated competition which has prevented co-operation between manufacturers.

The confusion resulting from special governmental specifications is detailed elsewhere in these columns by Charles F. Scott, who states that "a demand for something special, when that which is standard might be used, shows inferior rather than high engineering ability. The best engineer seeks to adopt his conditions so that he may utilize the things at hand, the standard products which are upon the market."

Ever since the twelfth century, when King Henry of England ordered that the ell, the ancient yard, should be the exact length of his arm, the trend of modern progress has been toward standardization. An era of standardization is a necessary corollary to this age of specialization. In many industries, notably the electrical, this fact has been recognized and standards have been adopted by mutual consent of manufacturer and consumer.

An instance familiar to everyone is the standard gauge for track width which was adopted by the railroads years ago. Edison is now quoted as saying that the choice of a four-foot, nine and one-half inch gauge instead of a six-foot gauge was a fundamental mistake and that the latter may yet be adopted. The selection of a standard does not necessarily mean that thereby future changes in the art cannot be utilized. From time to time conferences must be held to keep the standards abreast of the improvements. An excellent example of this is furnished by the standardization rules of the American Institute of Electrical Engineers, which are to be subject to frequent revision. While creative effort is not to be discouraged, there is now a great and crying demand for collaboration and standardization of what has already been accomplished.

Steam Engineering

The profession of steam engineering is one whose scope is but partially appreciated by men of other professions. The steam engineer is frequently considered only as a part of the machine or device that public convenience or modern living requires, a mere link in the chain of necessities. Some so-called steam engineers are no better than indicated by this classification. They would not be better in any other vocation. They belong to that self-satisfied, unprogressive host which is easily lost in the multitude. Their very lack of energy assists them to the smooth path of least resistance, where they cannot but journey with the mass whose course is fixed and whose aim is only of today.

But for the progressive men, for the leaders in thought and purpose, those who set the guide-posts of progress and see that this great mass wends its way along without injury to itself, for them the profession of steam engineering is pregnant with all the hope and purpose and reward of science.

When such a man as Professor Robert H. Thurston of Cornell University, whose eminence as an authority on the steam engine is recognized throughout the civilized world, after twenty-five years of uninterrupted employment as a specialist in technical college work and thirty years of practical experience in the design, construction, management and scientific investigation of the principles of the steam engine, when such a man can find in the study of the steam engine and its development an exhaustive application of the principles of chemistry and physics, of the science of energetics and its principal branch thermodynamics, surely it is a subject worthy of the respect shown the learned professions. Its students need fear no sacrifice of dignity when for the advancement of this all-important factor in modern industrial life they go about their duties in the obscure and noisy engine rooms.

The development of the steam engine itself gives proof of the breadth of the profession. Its development has resulted indirectly from the discovery of the mechanical theory of heat, the science of thermodynamics being the direct result of this theory. The application to the steam engine of the laws of heat transference, transmission and transformation, as covered by the principles of thermo-dynamics, was at first crudely and later slowly put into more definite and calculated form. Finally by theory the elimination of unnecessary wastes and the reduction of unavoidable losses has given us the engine of the present day. This latter stage of the development is still in process of rapid advancement.

The principles going into the action of the steam engine include chemical, physical and dynamical transformations. The combustion of the fuel, for example, is a chemical transformation of a very complicated nature and a profitable one for study and research. The generation of steam is in itself a physical phenomenon, as is also the transfer of heat from the fire to the water. The dynamical or energy changes taking place in the engine cycle are, as already stated, the most recent subjects of study, and it is in these that the rapid progress of late years and the prophetic hope for its continuance exist.

Thus the problem before the steam engineer is the determination of the amount of heat energy, or its mechanical equivalent, in a given amount of fuel; the determination of the percentage of this energy which is available by combustion; the percentage of this available energy which actually reaches the water in the boiler; and then the series of subsequent losses due to conduction, radiation, pressure variation, etc., till finally the actual mechanical energy is produced at the piston. This quantity, plus the losses, so determined, should then equal the original calculated amount of energy present. In the analysis of each of these losses, there come into play the principles of the sciences of chemistry, physics, mathematics, and mechanics.

With the steam engine more than with many equally important products of engineering skill, the development has been first experimental and then theoretical. Thus it was not until it was observed that heat was generated when boring a cannon in the middle ages that physicists began the series of calculations which established the law of the mechanical equivalent of heat. The tendency in recent years is, however, toward a reversal of the procedure. In fact, the development of thermo-dynamics as a science has been theoretical and the present-day high economy, high expansion engines, steam turbines and application of superheat, forced draft, etc., are products of advanced theory.

We have, however, much experimenting to do on the theories already advanced before a fixed and standard design can be obtained. Thus it has but recently been found, and this through a co-operation of theory and experiment, that the steam turbine is better adapted to the lower stages of pressure and that the reciprocating engine maintains higher economics in the upper ranges.

This experimenting and standardizing will be done to a great extent by the operating engineers. They have at their command, if they will but exert themselves to possess it, all the knowledge of the engineers and scientists who have preceded them. There is every reason to believe that the rapid advances of the past few years, wonderful as they have been, will be continued in the years before us. The status of the steam engineer of the future is then entirely what he chooses to make it—and all the opinions of the disinterested or possibly envious who see fit to make comment about his affairs cannot in the least affect him.

PERSONALS.

O. E. Thomas, an electrical engineer from Los Angeles, was in San Francisco this week.

W. H. Kline, formerly tax agent of the San Francisco Gas & Electric Co., is now general agent.

C. E. Groesbeck, general manager of the San Diego Gas & Electric Company, is in San Francisco.

R. B. Elder, district manager of the Allis-Chalmers Company, 160 Second street, San Francisco, is in Los Angeles.

President Scranton of the American Electric Heating Company of Detroit, is calling on the San Francisco trade.

H. C. Keyes, who has natural gas interests in Sacramento, spent a few days in San Francisco on business last week.

C. R. Downs, manager of the Amador Electric Light & Power Company of Sutter Creek, Cal., is a San Francisco visitor.

Julian Thornley has accepted a position as resident engineer at the dam for the Great Western Power Company, with headquarters at Big Bend.

E. F. Scattergood, chief electrical engineer for the Los Angeles Aqueduct Power, has been transferred to the grade of Member American Institute of Electrical Engineers.

H. H. Sinclair, vice-president and general manager of the Great Western Power Company, has returned from an inspection of the hydro-electric transmission plant at Big Bend. He was accompanied on the trip by George R. Field, the assistant manager.

H. R. Sargent, engineer of wiring devices, of the General Electric Company of Schenectady, N. Y., and G. C. Osborn, assistant to the manager of incandescent lamp sales, of the same manufacturing concern, left for the North the middle of the week, after spending several days in San Francisco.

P. D. Wagoner has been elected president of the General Vehicle Company, Long Island City, succeeding J. Howard Hanson, who has withdrawn from the company. Mr. Wagoner brings to his new work a wide experience in engineering and commercial affairs, and under his administration, the outlook for the future of the General Vehicle Company appears very bright.

George C. Holberton, the former engineer of electrical distribution, has been made general manager of the San Francisco Gas & Electric Company, under President John A. Britton. The latter is also president and general manager of the Pacific Gas & Electric Co. Other changes in the titles and personnel of the San Francisco Gas & Electric Co. effective February 15, are as follows: Archie Rice is now in charge of the publicity department; F. E. Cronise has taken charge of the new business department.

H. M. Byllesby of Chicago, who has been prominent in electrical engineering fields for many years, left this week after spending several days in San Francisco with a party of ladies and gentlemen, including W. F. Stevens Jr., of Chicago. Mr. Byllesby has been connected with both the General Electric and Westinghouse interests in past years and now controls electric power systems at San Diego and Coos Bay. It is rumored in engineering circles that he is in the market for additional electric power installations, including, possibly, one near Walla Walla, Wash.

P. M. Hunt, of Hunt, Mirk & Co. of San Francisco, has returned from El Paso, Texas, where he spent the past two months in installing a complete electric power plant for the Southwestern Portland Cement Company. He was accompanied by K. G. Dunn, who made satisfactory tests of the new installation, which includes two 750-kw. Westinghouse-Parsons turbo-generators, boilers and auxiliaries. The power plant occupies a separate building from the cement mill, which is operated throughout by electric motors. The location, on the banks of the Rio Grande river, three and a half miles from the city of El Paso, is a very suitable one for manufacturing.

Newly elected associate members of the American Institute of Electrical Engineers include: E. L. Barnett, electrician, Union Lumber Co., Fort Bragg, Cal.; Elmer Hurd, foreman of construction, Pasco Reclamation Co., Pasco, Wash.; D. F. Keith assistant station superintendent, Grace Station, Telluride Power Co., Provo, Utah; Laurids Lauridsen, engineer, W. S. Barstow & Co., 419 Failing Building, Portland, Oregon; O. L. Le Fever, foreman of subway construction, W. S. Barstow & Co., 419 Failing Bldg., Portland, Ore.; W. A. Newman, electrical inspector, the Board of Fire Underwriters, Port'and, Ore.; L. W. Sowles, Utah Light & Railway Co., 130 East Third street, Salt Lake City, Utah; O. C. Warner, second lieutenant Coast Artillery Corps, United States Army, Fort Worden, Wash.; George M. Wills, the Nevada-California Power Co., Goldfield, Nev.

LOS ANGELES SECTION A. I. E. E.

The February 25, 1910, meeting of the Los Angeles Section, A. I. E. E., will be addressed by R. W. Shoemaker on the subject of "Electricity in Mining."

A. I. E. E. MEETING AT SAN FRANCISCO.

A meeting of the A. I. E. E. under the auspices of the High-Tension Transmission Committee will be held in San Francisco, Cal., on Thursday, April 21, 1910. Among the papers which will be presented at this meeting are the following: "The Economics of a General Power System," by John A. Britton; "The Developed High-Tension Network of a General Power System," by Paul M. Downing; "Hydroelectric Developments and Irrigation," by John Coffee Hays. Further details regarding this meeting will be published later.

PORTLAND SECTION, A. I. E. E.

The Portland Section, A. I. E. E., met in the Knights of Pythias Hall at Eleventh and Alder streets, Tuesday evening, February 15, 1910. The following papers were presented: J. J. Brady, "Electric Drive in Car Shops"; A. W. Cochran, "Printing Presses"; R. F. Monges, "Gold Dredging"; H. R. Wakeman, "Conditions of Motor Application on Large Lighting Systems"; L. B. Wickersham, "Electrical Installation for Mining Plants"; G. H. Sampson, "The Separation of Metal by Volatization and Recondensation."

ELECTRICAL MEN'S CLUB OF LOS ANGELES.

The Electrical Men's Lunch Club of Los Angeles were entertained by the silvery-tongued orator, Mr. George A. Cole of San Francisco, at the regular monthly meeting February 10, 1910. Mr. Cole outlined the coming exposition to be held in San Francisco and became eloquent in his description of the different prospective exhibits. That he was prepared for the speech was demonstrated by his carefully prepared notes, the accuracy of which is doubtful, because of the fact he missed the date of opening the exposition over a month. However, as no one else was allowed to speak, his remarks were greatly appreciated. Mr. Cole remarked that he had come to Los Angeles to stay for a year, and would appreciate being called upon to make a speech every meeting. (The club pays for the speakers' lunch at each meeting.) Secretary Clapp made a report of the financial standing of the club, which shows sufficient cash on hand to bear the expenses for another six months. Chairman Ballard presided over the meeting, which means success to anything, and the fact of having the privilege of basking in the sunshine of his presence undoubtedly had a great deal to do with calling out the sixty-five members present (Mr. Cole's speech notwithstanding).

NEWS OF THE STATIONARY ENGINEERS

PREAMBLE.—This Association shall at no time be used for the furtherance of strikes, or for the purpose of interfering in any way between its members and their employers in regard to wages; recognizing the identity of interests between employer and employe, and not countenancing any project or enterprise that will interfere with perfect harmony between them.

Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the business of the Association, and at all times preference shall be given to the education of engineers, and to securing the enactment of engineers' license laws in order to prevent the destruction of life and property in the generation and transmission of steam as a motive power.

California.

No. 1. San Francisco, Thursday, 172 Golden Gate Ave. Pres., P. L. Ennor. Sec., Herman Noethig, 816 York St.

No. 2. Los Angeles. Friday, Eagles' Hall, 116½ E. Third St. Pres., J. F. Connell. Cor. Sec., W. T. W., Curl, 4103 Dalton Ave.

No. 3. San Francisco. Wednesday, Merchants' Exchange Bldg. Sec. David Thomas, 439 Merchants' Exchange Bldg.

No. 5. Santa Barbara. Geo. W. Stevens, 2417 Fletcher Ave., R. R. No. 2.

No. 6. San Jose. Wednesday. Pres., W. A. Wilson, Sec., Lea Davis, 350 N. 9th St.

No. 7. Fresno. Pres., A. G. Rose. Sec., E. F. Fitzgerald, Box 651.

No. 8. Stockton. Thursday, Masonic Hall. Sec., S. Bunch, 626 E. Channel St. Pres., H. Eberhard.

Oregon.

No. 1. Portland. Wednesday, J. D. Asher, Portland Hotel. Pres., B. W. Slocum.

No. 2. Salem. A. L. Brown, Box 166.

Washington.

No. 2. Tacoma. Friday, 913½ Tacoma Ave. Pres., Geo. E. Bowman. Sec., Thos. L. Keeley, 3727 Ferdinand St., N., Whitworth Sta.

No. 4. Spokane. Tuesday. Pres., Frank Teed. Sec., J. Thos. Greeley, 0601½ Cincinnati St.

No. 6. Seattle. Saturday, 1420 2d Ave. Pres., H. R. Leigh. Sec., J. C. Miller, 1600 Yesler Way.

Practical letters from engineers and news items of general interest are always welcome. Write your items regardless of style. Communications should be addressed to the Steam Engineering Editor.

PRACTICAL MECHANICS.

(Paper No. 7—Continued)

Axes of rotation crossing. There has not as yet been devised a means for transmitting rotation between crossing shafts by means of a coupling or rigid intermediate member.

Before leaving link-work transmission, mention should be made of the ratchet or click movements. These are properly classed with this form of transmission because one end of the click or pawl is usually supported by a pin while the other is temporarily acting in a notch which is equivalent to a pin support. The ratchet is applicable in its various forms to axes variously related and is, in fact, a very common form of effecting rectilinear translation from rotation as in the application of certain forms of steam engine lubricators; in the old-fashioned sawmill log feed, or in the machine drill press. Nothing complex is involved in applying ratchet movements where intermittent action is desired; each case having to be considered as it arises and handled as appears most expedient.

Transmission of Pure Rotation by Rolling Contact. Having covered the most important cases of transmitting pure rotation by means of a rigid intermediate member, we now proceed to subdivision I of the original outline for these papers, (see January 1st, 1910, issue), and shall for a time be concerned with transmission by rolling, on frictional contact.

Rolling Contact in General. Rolling contact is understood to imply the driving of one rotating body, the follower, by a driver rolling against it. The axes of motion are necessarily at a fixed distance apart and the point, or line, of contact between the two members will lie in the plane of their centers. The line of contact is a straight line.

As was done in the study of link-work, we shall here subdivide our study into three cases:

1—Axes of rotation parallel either in the same straight line or otherwise.

2—Axes of rotation intersecting, without meeting.

3—Axes of rotation crossing.

In all three cases there are certain features which may receive general consideration.

The velocity ratio will be the inverted ratio of the respective radii to the point of contact. This was shown in paper No. 4, (see issue of January 22d). It is evident that for non-slipping contact the two arcs which have rolled together for any finite time must be of equal length.

For the transmission of power there must be either a component of the driving force normal, or perpendicular to the curves at the contact point, or if this component does not exist there must be a coefficient of friction sufficient to prevent slipping. In order that there may be a normal component of force at the point of contact of two surfaces rolling together the contact radius of the driver must be constantly increasing. Hence for this condition the curves cannot be closed curves.

For the existence of a frictional coefficient there must be a force P pressing the two axles together. The force K tending to drive the follower is then a percentage of P and is usually designated as such that $K = P$.

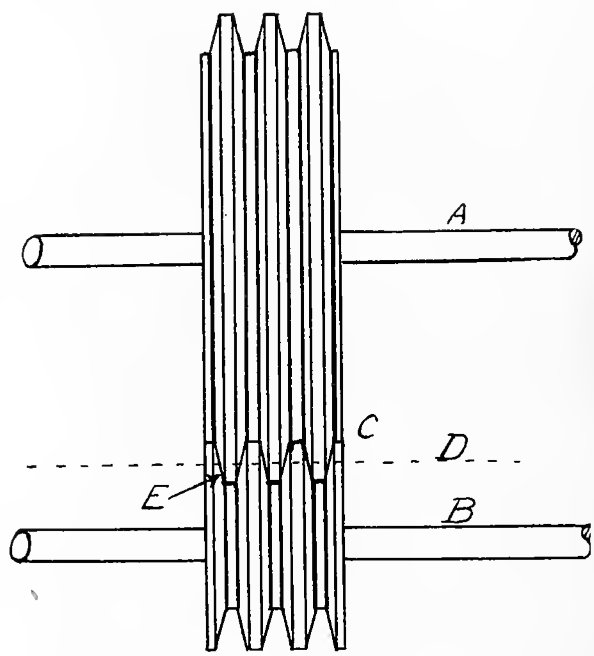


Fig. 8.

If K is to be large it is evident that either Q or P must be large. Since a large force P *means* excessive bearing friction and large journals it is desirable to keep P as small as possible, hence a large frictional coefficient should be obtained. To accomplish this special contact surfaces may be used which have large frictional coefficients. Resort is sometimes had to grooved surfaces which intermember in such a way as to produce heavy pressure between surfaces nearly radial and thus high frictional coefficients are obtained with small bearing pressures. In practice the angles of ridges and grooves are made about 30°. In figure 8, A represents one shaft and B the other, the grooved frictional gearing being shown at c. It is obvious that there will be one contact point—the pitch circle shown at D at which there will be no slipping, but other points as E, on the groove of either member will be forced to slip or rub. This causes a friction loss which lowers the efficiency. This rubbing has been partially eliminated by making the grooved surfaces curved instead of straight as shown in figure 8 and thereby permitting them to touch in but a single point. The bearings must of course permit of taking up the wear in the grooves. Another disadvantage of grooved gearing is the journal friction which is considerable where any large amount of power is to be transmitted. This form of gearing will be found on ship-winches where efficiency is subordinate to speed and ruggedness.

INDUSTRIAL

A NEW TYPE OF CONTROLLER FOR MOTOR DRIVEN VALVES.

Our great waterfalls are among the most awe-inspiring of nature's creations and their grandeur and sublimity have attracted visitors from all parts of the world. Yet nature evidently intended that they should fulfill another mission and play a prominent part in the attainment of a higher state of civilization. At the present day the grandeur of natural scenery is giving place to scenes more in keeping with the requirements of civilization, large hydraulic power houses are springing into existence beside the waterfalls, and the water motor, coupled to the electric generator, is transforming the potential energy of these great masses of water into electric power for transmission to distant points and distribution to the general public.

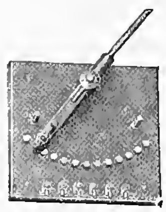


Fig. 1. Starting Panel of CR 130 Valve Controller.

The certain and quick control of the amount of water to be admitted to the water motor, under all conditions of opertion, presents a problem which is best solved by the use of motor driven valves provided with remote control. Such apparatus must be of rugged and substantial construction, as it is subjected to very severe service. The motor is required to start quickly under full load, and thus must take a large starting current. It must also stop instantly.

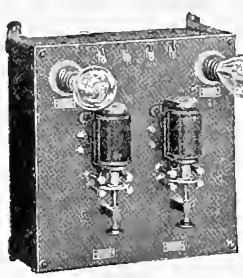


Fig. 2. Control Panel of CR 130 Valve Controller.

The General Electric CR 130 controllers have been designed for this service and consist of three separate parts, starting panel, control panel, and limit switch. The control panel only is placed at the point from which the valve is to be controlled. The starting panel can be placed anywhere, while the limit switch is connected directly to the valve stem.

The general appearance of the starting panel is shown in Fig. 1. The circuit is made and broken by contactors, the magnetic blowout feature of which enables them to open the circuit without appreciable arcing. Two of the contactors close the motor circuit for one direction of rotation and the other two for the reverse direction.

As the majority of the motors operating valves are series or compound wound direct current, those up to and including 5 h. p. may be thrown directly on the line without the interposition of a starting resistance. The panel illustrated in Figs. 1, 2 and 3 is for this service.

The controllers designed for medium sized motors, have additional contactors which cut resistance into or out of the armature circuit. For large motors requiring at least seven steps of starting resistance, the panel is mounted upon pipe supports and the extra contactors are replaced by a solenoid operated switch.

The controllers are equipped with the new CR 187 units which are non-fragile, fire and moisture proof, and thoroughly ventilated.

The control panel shown in Fig. 2 contains two pilot lamps for indicating the position of the valve gates, and two relays for closing the circuit of the coils which close the contactors. The relays are so interconnected that should one be closed and an attempt made to close the other, the one previously closed would open, preventing any possibility of a short circuit resulting from this action and making the device "fool proof."

The switch arm of the limit switch is moved over the contacts by a rod attached to the valve stem. The length of the rod is so adjusted that when the valve is completely opened or closed the limit switch is either at the upper or lower end of its travel, where it short circuits the coils which close the contactors allowing the latter to open, disconnecting the motor from the line.

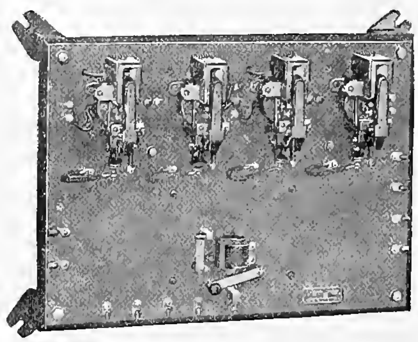


Fig. 3. Limit Switch of CR 130 Valve Controller.

The valve is opened by pushing up the core of the relay marked "to open" on the control panel, closing the circuit through two of the contactors on the starting panel and applying half voltage to the pilot lamp causing it to burn dimly, indicating to the operator that the valve is being opened. When the limit switch opens the line contactors it also applies full voltage to the pilot lamp which then continues to burn at full brilliancy as long as the valve remains open. The pilot lamps indicate the position of the valves at all times.

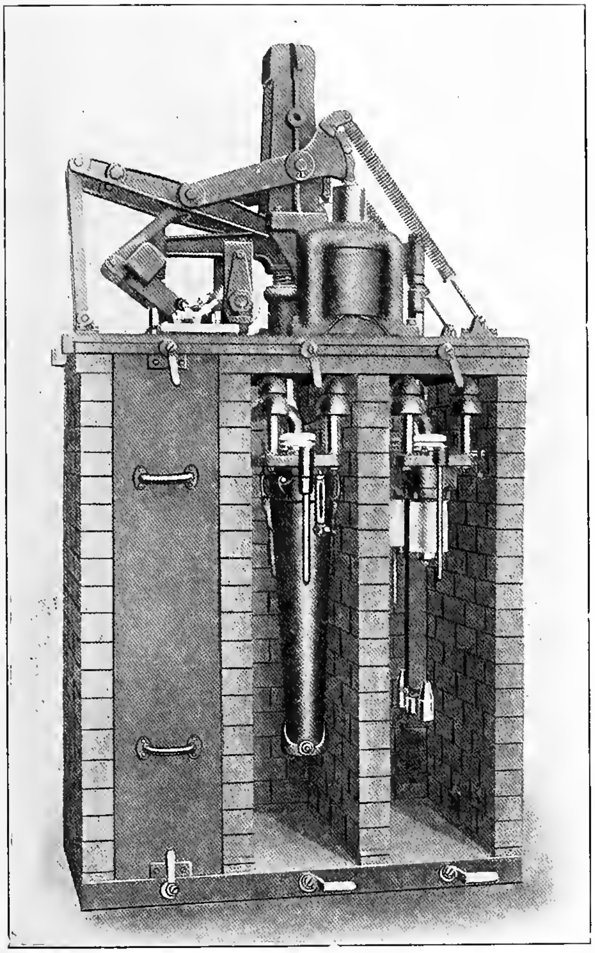
TRADE NOTES.

H. W. Johns-Manville Co., New York, who are the sole selling agents for the well known line of "Noark" Enclosed Fuses, and accessories, manufactured by the Johns-Pratt Company, of Hartford, Conn., announces that on December 14, 1909, the United States Circuit Court of Appeals for the Second Circuit held that the Sachs Company, and Joseph Sachs its president, have infringed the Sachs patent for enclosed safety fuses, No. 660341, belonging to the Johns-Pratt Company. In the opinion rendered by the court the patented invention is described as "a thin flat metal fuse-strip of extended area in contact over its entire surface with non-conducting filling," and it is said "that the novelty which the patentee sought to secure consisted in making the fuse-strip of thin flat metal of extended area instead of a wire or other strip having a compact sectional area, the object being to increase the surface of the metal with which the filling is in contact, so as to insure its immediate dispersion, when fused, in the filling material." The court holds that the flat strip fuses of the Sachs Company contain this patented invention and are infringements of the patent.

WESTINGHOUSE NO-VOLTAGE RELEASE TYPE "C" OIL CIRCUIT BREAKERS.

For controlling eight large 6600-volt Westinghouse type "HF" three-phase induction motors, ranging over capacities of 3200, 2500, 2000 and 650 h. p., in the new merchant mills of the Indiana Steel Company, at Gary, the Westinghouse Company has equipped its standard type "C" circuit breakers with a no-voltage release device, which secures the instantaneous opening of the gravity-operated contacts when the control voltage is interrupted.

As shown in the accompanying illustration, one of the toggle-joint members of the standard switch-gear is fitted



Oil Circuit Breaker.

with an armature which engages and is held by the pole pieces of the no-voltage coil, just before the toggle passes its central position. In the ordinary type "C" breaker furnished without this toggle no-voltage release, the contacts are held closed by carrying this toggle over its dead center, where it locks.

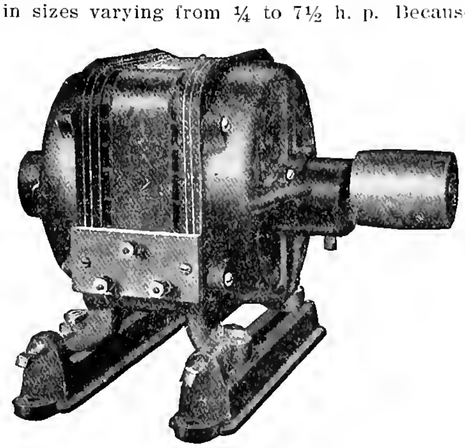
In the no-voltage type, the toggle is detained by the attraction of the pole pieces for the armature, while still on the operating side of its center, so that in case of any interruption to the control voltage the breaker immediately opens, and cannot be closed except in the usual manner. Full protection is thus afforded to the motors connected through their circuit breakers, and in the case of overload on the rolls, or failure of the power house, their circuits are immediately opened, so that the machines must be gradually accelerated in the usual way.

Except for the no-voltage release feature, these circuit breakers are similar to the standard type "C" oil breakers built by the Westinghouse Company, and include all the features of solenoid operation, oil submersion of contacts, simple lever switch-gear, gravity opening, and minimum quantity of oil required, which are among the advantages of the well-known type "C" breakers. The breaker is designed for mounting in a brick or concrete structure, separate cells enclosing the sheet-metal switch tanks of each phase. There are two contacts per pole, an effective barrier between pairs of contacts being interposed by the operating rod and insulating lining of the tank. No high tension parts or wiring is exposed when the breaker is assembled. A double-throw, double-pole switch operated by the controlling levers serves as a tell-tale, lighting red or green lamps to show the position of the contacts, whether open or closed.

Besides such special services as large motor starting duty, type "C" oil circuit breakers equipped with no-voltage release will be found extremely useful inserted in the service mains of large power customers, where, by opening the circuit promptly, they will relieve the heavy load conditions met by the power house in restoring service after an interruption.

KIMBLE POLYPHASE INDUCTION MOTOR.

Parrott & Co., Pacific Coast representatives of the Kimble Electric Co., of Chicago, now have in stock a full line of Kimble induction motors including the three-phase machine herewith illustrated. These three-phase motors can be had in sizes varying from ¼ to 7½ h. p. Because of the



Kimble Polyphase Motor

terminal connections on the motor they are particularly easy to install. They are smooth running and so designed as to have a minimum of slip. Their high starting torque combined with low starting current eminently fit them for machine drive. The manufacturers claim a high efficiency and high power factor and also guarantee their product for two years' time.

Remodeling its generating station at Amarillo, Texas, the Amarillo Water, Light & Power Company has recently installed a Westinghouse bituminous gas-producer plant for supplying its 300 h. p. Westinghouse gas-engine-driven alternator set. This new bituminous type T producer is charged with coal costing $3.50 to $4.75 per ton, and delivers fuel gas having a calorific value of 110 effective b. t. u. per cubic foot. The gas engine is of the single crank horizontal type, with cylinder 18 by 26 inches, and delivers 300-brake h. p. Three-phase, 60-cycle power, generated at 2300 volts, is used for local lighting and power in Amarillo. The development of a successful bituminous gas-producer plant has received the attention of the engineers of the Westinghouse Machine Company for several years, and in this direction severe and prolonged tests were carried out on the apparatus, before the present highly successful bituminous producer was placed on the market.

NEWS NOTES

INCORPORATIONS.

SOUTHSIDE, WASH.—The South Telephone Company, with a capital stock of $50,000, has been incorporated by W. A. Kiser, L. J. Coonan and W. R. Ball.

NEHALEM, ORE.—The Nehalem Telephone & Telegraph Company have a capital stock of $3000. The incorporators are S. Scovell, Rudolph Zweifel and Geo. R. McKimens.

ALAMOGORDO, N. M.—The Alamagordo Gas Co., with a capital of $100,000, has been incorporated by Walter Harpst, F. A. Kitchen, E. K. Zimmerman and Geo. Palda of Cleveland, Ohio; A. F. Menger of Alamagordo.

HICKSVILLE, WASH.—The Wheeler Telephone Company of Moses Lake, with a capital stock of $2000, has been incorporated by C. G. Henerson, George O. Rinehart, W. H. Thompson, E. S. Durham and W. E. Kapp.

FULLERTON, CAL.—The Helena Orchard Water Company, of Fullerton, with a capital of $75,000, has been incorporated. The directors are S. F. Catey, Los Angeles; W. S. Davis; A. I. Stewart and F. R. Bain of Fullerton.

SANTA ANA, CAL.—The Red Hills Water Company, with a capital stock of $50,000, has been incorporated. The company is organized for the purpose of buying and selling land and water rights. Tustin is the principal place of business. The directors are C. E. Utt, Sherman Stevens and Mary E. Utt.

SPOKANE, WASH.—Spokane Railway & Power Company, capitalized at $2,000,000, has filed articles of incorporation to build a plant to develop between 30,000 and 35,000 horsepower in the Spokane river, 30 miles below Spokane. The plant will cost $1,500,000 and is to be in operation within two years. The incorporators are D. M. Drumheller and Alfred Coolidge of the Traders' National Bank and H. L. Moody, a local capitalist, the latter being president of the company. Mr. Moody gave out this statement: "We will enter the Spokane market as distributers of electric light. This does not mean that we are in opposition to the Washing Water Power Company, but we recognize Spokane as an open market and we will develop our power for the purpose of sale and distribution in Spokane. We will be able to sell power delivered in Spokane at $14 a horse power. Our power plant will cost about $1,500,000 when completed. We will build a dam at a point on the Spokane river near the Le Pray bridge, which is a famous old landmark in this country. The site has already been acquired and we have secured most of our riparian rights. We expect to develop between 30,000 and 35,000 horsepower with our plant, which will be modern in every respect. Preliminary work will be started as soon as the weather will permit. As soon as our plant is completed we will run power lines to Spokane and the surrounding country."

TRANSMISSION.

HOPE, B. C.—The Fraser Land Company is preparing to erect a power plant here.

NORTH YAKIMA, WASH.—The Wenas Electric Power Company has been incorporated.

ROUNDUP, MONT.—The Roundup Coal Mining Company is making arrangements for the complete electrification of its line.

WENATCHEE, WASH.—Wenatchee Valley Railway & Power Company has been incorporated for $2500 by H. A. Chapin et al.

PORTLAND, ORE.—Plans are under way for installing a lighting system for First street. To be the same as that on Second street.

BLACKFOOT, IDAHO.—A franchise has been granted to the Idaho Consolidated Power Company to install an electric light, power and telephone system.

WALLA WALLA, WASH.—It is reported that R. A. Stephenson of Mason City, Iowa, and other Iowa capitalists will erect an immense power plant on the Snake river for the purpose of supplying this and other cities with power.

SPOKANE, WASH.—David L. Huntington, general manager of the Washington Water Power Company of Spokane, announces that the plant at Little Falls on the Spokane river, 34 miles below Spokane, will be ready for operation early in June. The work on the plant, which will develop more than 30,000 horsepower, has been in progress 22 months. The turbines, of which there are four, are designed to develop upward of 9000 horsepower if put to fullest capacity. "We now have 100 miles of street railway and 430 miles of high tension transmission line running into neighboring cities and as far away as the Coeur d'Alene mining district," said Mr. Huntington. "Our load is increasing all the time and we will need all the additional power we can develop. Our aim is to keep building just fast enough so as to have a safe margin at all times." With a total length of more than 900 feet, in the neighborhood of 50,000 cubic yards of concrete are required in the construction of the dam and the buildings. With the exception of an opening for the passage of teams the core wall of the dam is practically complete. The generating room is 155 by 71 feet, the transformer and switchboard room being 161 by 70 feet, the height above water level is 80 feet. There is a fall of 68 feet in the stream. The transmission line from the new station will be 28½ miles in length and will connect with the present lines at the Twenty-ninth avenue, sub-station. At present the largest power station in the Northwest is located at Post Falls, Idaho, 24 miles above Spokane on the Spokane river. It is owned by the Washington Water Power Company. Eighteen thousand horsepower can be developed at this plant. The Washington Water Power Company's station at the falls in Spokane is capable of developing 12,000 horsepower.

TRANSPORTATION.

OAKLAND, CAL.—An electric road franchise asked by the Peninsula Railway Company, has been voted advertised.

ASTORIA, ORE.—Preparations are being made to commence the grading for the line of the proposed electric railway to Seattle.

SEATTLE, WASH.—The Puget Sound Electric Company is planning to make improvements to cost $376,591 in its line between Seattle and Tacoma.

SAN RAFAEL, CAL.—Active steps are being taken to build an electric street railway from Corte Madera through Ross Valley towns and San Rafael to McNears Point.

ONTARIO, CAL.—The City Council passed an ordinance granting to Wm. G. Kercheff the right to construct and maintain an electric railway upon certain streets in this city.

ALBANY, ORE.—The Albany Interurban Railway Company has been incorporated for the purpose of building an electric railway from here to Sweet Home. P. A. Young is one of the incorporators.

ABERDEEN, WASH.—At the last meeting of the County Commissioners the Grays Harbor Interurban Company made

application for a new franchise to operate a trolley line on the roads of Chehalis County.

PORT ANGELES, WASH.—The Port Angeles Power & Electric Company, capital $80,000, has been incorporated by Frank MacKean, Pacific block, Seattle, and R. H. Bethel.

LOS ANGELES, CAL.—The Board of Supervisors is receiving sealed bids for furnishing the county one single 220 volt, 4 ton electric locomotive, to be delivered free on board the cars at the Pacoima rock quarry.

BERKELEY, CAL.—The S. P. Company has petitioned the City Council for the withdrawal of its application for a change in the franchise granted last year, and also asks for a new franchise, changing the line of the road some 300 feet on California street in the northern part of the city. The application has been referred to the committee of the whole, and a report will be made at the next meeting of the City Board.

LOS ANGELES, CAL.—The Assistant City Attorney has announced that the Los Angeles Pacific Railway Company has agreed to stop laying further tracks on Western avenue, Colegrove district, until the company's rights there are definitely ascertained. Between Monticello and Benedict streets, the avenue is but 60 feet in width and ties were laid in the gutter, making the adjoining property inaccessible. The Board of Public Works wants the tracks laid in the center of the avenue.

OREGON CITY.—The Portland Railway, Light & Power Company has commenced the construction of an electric railway from West Oregon City to Oswego, a distance of four miles, in order to handle the logging business for the Willamette Pulp & Paper Company, the Crown-Columbia Pulp & Paper Company and the Hawley Pulp & Paper Company. The line will be an extension of the Willamette Falls Railway, running south from West Oregon City past Willamette. It is intended to have the road in operation in three months.

SAN FRANCISCO, CAL.—Dr. Hart'and Law and a special committee of the Nob Hill Association have had preliminary plans prepared for a tunnel under that part of Stockton street from Bush street to a point a short distance north of Sacramento street. It is estimated that this work will cost between $350,000 and $375,000, a small sum in comparison with the benefits to be derived from the improvement, in the opinion of the members of the association. The plans call for a tunnel as wide as the street, which is to be lined with glazed brick, thus combining ornamentation and utility. The grade in the tunnel is not to be over 3 per cent.

SACRAMENTO, CAL.—As soon as the Northern Electric Railroad secures the permission of Sacramento and Yolo counties and the government to erect a bridge across the Sacramento river from this side the extension of the line to Woodland will be undertaken. This is the information which comes indirectly from company officials. President Lillienthal of the Northern Electric states that Sacramento was the logical market for the residents around Dixon and Woodland, but would give no details of a contemplated extension of the trolley line there. Mayor Beard has offered a solution to the Northern Electric's plan to cross the river at M street, which is meeting opposition, by suggesting that the new bridge cross at I street.

RED BLUFF, CAL.—The Northern Electric Railway Company, now operating the system between Sacramento, Oroville, Marysville and Chico, has filed deeds here by which it secures rights of way across Los Molinos colony in this county, 12 miles below Red Bluff. The deeds are granted free on condition that the railroad be extended from Chico to Los Molinos before the end of 1910, and on to Red Bluff before the close of 1911. It is supposed that the company will stop building at Los Molinos, and the completion of its road to Red Bluff this year is confidently expected, with an an extension to Redding and Kennett next year. Other necessary rights of way have nearly all been secured, and they are near the line of the Southern Pacific nearly the entire distance. The deeds just filed cover 12 miles of the distance between Chico and Red Bluff. The road will pass through one of the best portions of the Sacramento Valley, where rapid development is taking place on account of the influx of Eastern people. The company will also soon build from Yuba City through Meridian and Colusa to Hamilton City.

ALAMEDA, CAL.—That electric trains will be running on the Alameda main local lines to the Alameda mole by April 1 has been announced by F. W. Hoover, industrial agent for the Southern Pacific. The powerhouse, which will supply power for all the electric lines on this side of the bay, will not be finished until August 1, but Mr. Hoover states that the railroad company had a contract with the Great Western Power Company to supply current for the electric trains until the powerhouse can be put into operation. Poles to carry the high power lines have been erected along Encinal and Lincoln avenues, and the roadbed has been prepared for the new traffic and heavier rails installed where necessary. The work on the loop around the east end of the city is nearly finished. The Linderman estate has held up the work on the loop extension, but it is said that the city of Alameda will condemn the right of way if necessary. Seven new stations on the local lines are under course of construction. As soon as the Alameda lines are electrified work will commence on the extension across the estuary to the Franklin street station.

ILLUMINATION.

FOREST GROVE, ORE.—The City Council has authorized the Mayor to buy machinery for a plant to supply Forest Grove with electric lights.

GEORGETOWN, WASH.—Robert M. Jones has been granted a franchise to erect, maintain and operate a gas, electric light and power works.

KENNEWICK, WASH.—The Hanford Irrigation and Power Company will resume the improvement work started in the town of Hanford last year, including a water and lighting system.

SEATTLE, WASH.—The American Gas & Electric Power Company, of which B. H. Silver is president, will build its first producer gas power plant in Georgetown. The plant is to be in operation within a year.

DRAIN, ORE.—The City Council has passed an ordinance to light the city with electricity, making a 20-year contract with the Drain Electric Light & Power Company. The company is to begin work within 30 days, and finish in eight months.

REDLANDS, CAL.—The new power plant of the Southern California Edison Company, proposed to be built in Santa Ana canyon, will probably be begun this spring or summer. The plant will have a capacity of 7000 kilowatt and cost about $600,000.

VENICE, CAL.—District Agent A. W. McPherson of the Southern California Edison Company has received official notice that reports of the gas experts of the company have received favorable executive action, and that work of rehabilitation and manufacturing and distributing systems at Ocean Park and Santa Monica will be commenced immediately.

DEMING, N. M.—Secretary E. A. Lane of the Deming Ice & Electric Company, and Manager Cameron, state that their plant will be increased in capacity. There will soon be installed two boilers of 250 h. p. each. The capacity of the ice plant will be about doubled and the electric business will

be increased. A large steam turbine will be directly connected to generator.

BAKERSFIELD, CAL.—The Standard Oil Company, which has for some time been using gas from its big gas well at Midway in its furnaces in the west side field, has laid a 4-inch main to the Rio Bravo pumping station of the Kern River-Midway pipe line, and for the past week has been burning gas there also. Tests are now being made at Midway to ascertain the velocity with which the gas flows through the pipe and to secure other data, which, if considered satisfactory, may result in continuing the pipe line to the Kern River field. The week's test of the gas at the Rio Bravo station demonstrates to a practical certainty the full feasibility of piping gas from Midway to supply heat and light in Bakersfield, provided a sufficient supply is obtained, and for this there is good reason to hope from the showing of the Standard's Midway well, which is capable of supplying 12,000,000 feet daily, with a pressure of 470 pounds. The amount used in the big furnaces of the pipe line is not missed from the well's apparent supply. The Standard's well at Midway which started off at 5000 barrels, is now flowing about 1500 barrels per day.

PORTLAND, ORE.—Seymour H. Bell, of 780 Kearney street, has returned from Tacoma, having sold the holdings of the Coos Bay Gas & Electric Company, at Coos Bay, to the H. M. Byllesby Company, owners of the Tacoma Light Company and several other plants throughout Washington, Montana and Idaho. The Coos Bay Gas and Electric Company owns the electric lighting plant at Marshfield and North Bend with a gas plant supplying both cities, located at the latter place. Associated with Mr. Bell in the company have been Henry Hewitt Jr., of this city, who owned the majority of the stock, and L. J. Simpson, of North Bend. Next to Stone and Webster, the H. M. Byllesby Company are the largest public service people on the coast and the purchase of the plant at Coos Bay is their first acquisition of property in Oregon. There has been a general renewal of activity in all lines of business at Coos Bay in the past few weeks and the announcement of a $400,000 deal will give fresh impetus to the already rapidly rolling ball. The property of the Coos Bay Gas & Electric Company consists of the old electric lighting station at Marshfield with a 35-year franchise for gas and electricity, and the new gas and electric power plant at North Bend, which is the central station, with a 50-year franchise for both gas and electricity there. The company has been supplying 24-hour service for two years.

TELEPHONE.

CENTERVILLE, WASH.—The Centerville Telephone Company has been incorporated for $5000 by Henry Garner et al.

SANDPOINT, IDAHO.—Articles have been filed for the Bonner County Telephone Company by T. C. Bell of Wallace.

WENATCHEE, WASH.—The South Side Telephone Company has been incorporated by W. A. Kiser et al. About 60 phones will be installed.

ZILLAH, WASH.—The Yakima Valley Telephone Company, C. H. Furman of this place, manager, will extend its service in Toppenish and Mabton.

TOPPENISH, WASH.—The Yakima Valley Telephone Company has increased its stock and will install a large number of phones in the city within the next three months.

PORTLAND, ORE.—The McCormick Lumber Company has closed a contract for the installation of wireless apparatus on its steamers—the Yosemite, Yellowstone, Cascade and Shoshone.

TWIN FALLS, IDAHO.—The Twin Falls-Jarbidge Telephone & Telegraph Company, M. J. Kirkpatrick is president, will soon begin the construction of a telephone line into the Jarbidge mining camp, 100 miles distant.

SANDPOINT, IDAHO.—C. R. Potter, present manager of the Interstate Telephone Company and farmers in the vicinity of Sagle, Cocolalla and Westmond, are taking steps to install a rural telephone service. Fifty miles of line will be constructed at a cost of $5,500.

WATERWORKS.

DORRIS, CAL.—The trustees of Dorris are negotiating with the United Iron Works of Oakland for a system of water works.

CRUSICK, WASH.—J. W. Crusick has purchased the engine, pump and tanks of the Irene Water Company and will install a water plant.

SILVER CITY, N. M.—The secretary of the treasury has submitted a letter to congress recommending an appropriation of $65,000 for a water supply at Fort Baynard, N. M.

BELLINGHAM, WASH.—Sealed bids are being received by J. H. Korthauer, city comptroller, for furnishing the city of Bellingham's water department with cast iron water pipes.

PACIFIC GROVE, CAL.—The Grove waterway contract has been let to Edward Simpson and C. W. Van Horn. This pipe line will run from Pine to Lighthouse by the way of Fourteenth street.

REDWOOD CITY, CAL.—At the suggestion of Mr. Tuchson the street superitnendent was instructed to lay water mains in Iris, Jeter, King, Lowell, Myrtle, Nevada and Hopkins streets before the streets are paved.

SEATTLE, WASH.—The City Council has passed a resolution for the improvement of Ninth avenue and Ninth avenue north from Westlake avenue north; Denny way, from the westerly margin of Ninth avenue, north to Westlake avenue; John, Thomas, Harris, Republican and Mercer streets, each from Ninth avenue, north to Westlake avenue north; and Roy street from Eighth avenue north to Westlake avenue north by the construction of sewers and water mains.

SAN JOSE, CAL.—Judge S. F. Lieb has received a telegram from Sacramento informing him that the Supreme Court had affirmed the judgment of the Superior Court of this county enjoining the Bay Cities Water Company from appropriating the water, subterranean and flood, of the Coyote river. The suit was one of a number instituted to restrain the water company from taking the water supply of the county which comes down the Coyote river. The case has been pending for a number of years, Judge Rhodes, then sitting in Department 3 of the Superior Court, having given judgment in 1905 against the Bay Cities Water Company, enjoining them from interfering with the Coyote waters. The Coyote river is the largest body of water in the county, over 200 square miles of mountain watershed being drained by it. Opposite the 18-Mile House on the Monterey road it bursts into the valley, and it again contracts down at the 12-Mile House so that it becomes nothing but a rocky gorge 300 to 400 yards wide and less than 100 yards deep. Underlying its course and for considerable depths to hardpan are immense areas of gravel which comprise great reservoirs that feed the underground streams leading to the artesian wells of the county. At the point named the Coyote is 240 feet above the bay and 140 feet above San Jose. It was estimated that this water supply would amount to 20,000,000 gallons a day and it was the purpose of the Bay Cities Water Company to impound this water and sell it to the highest bidder. It was offered to the city of San Francisco, and the company proceeded to put down machinery and pumps of a capacity to handle that amount of water, some of the works being sunk 80 feet below the surface of the ground. To restrain them from taking these waters was the purpose of the suits brought.

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THE STORY OF THE FOLSOM POWER PLANT

BY ARCHIE RICE.


Archie Rice

At the little town of Folsom, California, on the American river to the eastward of Sacramento, is the oldest of the eleven hydroelectric power plants now owned by the Pacific Gas and Electric Company. While not the first installation in America for long-distance transmission of electric energy, Folsom was among the pioneers. It was preceded only by the sixteen-mile power system installed in the latter part of 1892 for a mine at Bodie, California, and by a very few similar plants established after Bodie and before Folsom began, in July of 1895, sending electric energy through a twenty-two-mile power line to the city of Sacramento. There the current was to furnish light, operate machinery, and propel street cars.


Upstream Face of Folsom Dam, Showing Prison Watch Towers on Hill.

Circumstances often change the purpose of a man's life. An isolated farmer may be disturbed by the advent of a railroad and the creation of a townsite on his property. A few years later these circumstances may have changed the quiet rustic into a bank president, a hotel proprietor with a diamond stud, a man of affairs in his own community.

Unexpected developments in local and business conditions helped to bring about the establishment of that power plant at Folsom. It was a creature of circumstances, plus. And the plus was the personal energy of a few men — Horatio Livermore, Charles Livermore, and Albert Gallatin, Sr.

Back of the beginning of Folsom's advent as a producer of electricity there was a series of developing events covering a period of forty years and involving an old Spanish ranch, placer mining, a logging industry, state politics over the selection of a prison site, transfers of property ownership, six years of convict labor on the Folsom dam and power canal, disputes with state officials as to water privileges, and years of litigation, which was perpetuated in a case taken before the Supreme Court of California to determine

the relative rights of the power company and the state prison in the use of the water flow, and that case was not satisfactorily settled until the 29th of September, 1909.

In pioneer mining days the American river was a mint, where a great army of argonauts worked with shovel and rocker. Up the granite-ribbed bed of that stream, miles above Folsom, the middle and south forks of the river come together from two sides of the famous Georgetown Divide in El Dorado county. There James Marshall, in February of 1848, made the first discovery of gold in California. He happened upon it while repairing a water ditch at Sutter's mill. That Georgetown Divide district is mountainous. Half a century ago it was heavily timbered with sugar pine and yellow pine of exceptionally good quality.

Things were booming in the mines, and Sacramento was the commercial center of the mining industry. Lumber became a necessity, and its production a profitable enterprise. By 1855 the Sacramento Valley Railroad, from Sacramento to Folsom, was completed. It was the earliest steam road on the western slope of the continent. "Uncle George" Bromley, the well-known, jovial, nonagenarian member of the Bohemian Club, was its first passenger conductor. The day the first train ran was the most notable in Folsom's history. Men whose names loom big in the annals of California were there to celebrate the event. Five or six years later Stanford and Huntington and Crocker and Hopkins started the idea of a transcontinental railroad, and Stanford, as war-time Governor, lawyer, and personal friend of Lincoln, got the government land concessions that made possible the financing of the amazing undertaking. That little railroad to Folsom became in 1863 the initial part of the Central Pacific's transcontinental line.

These facts are not necessary to the story of the Folsom power plant, but they have a historical connection with it, because the very bricks of which the power house is made were part of the first railroad shops built at Folsom in 1855, upon the spot where the Folsom passenger station now stands. And just upstream from the power house is one of the original granite masonry abutments upon which rested the first bridge built for America's first transcontinental railroad.

In 1851 the Natoma Water and Mining Company had acquired some rights along the American river, and in 1857 it purchased from Charles W. Nystrom lands on the east bank, and also bought river-channel lands.

Horatio P. Livermore and his brother, Charles E. Livermore, were interested in the lumber business. They wanted to market a lot of that timber from the Georgetown Divide, and they had to have river rights that would permit them to float the logs down stream. So they had bought river land and acquired the "Rancho Rio de los Americanos," which suggests that the original Spanish name of that stream was "River of the Americans," probably called from the Americans like Sutter and others who settled along its course before gold was discovered.

In 1858 the California Legislature decided to establish a branch prison to supplement the original penitentiary at San Quentin, and a choice of location was restricted to the granite-quarrying district at Rocklin or the granite district near Folsom. Year after year no selection of a site was made by the prison directors, and the matter was allowed to drag.

The Livermores needed a still-water basin somewhere near Folsom to catch the logs as they came down stream. So, in 1866, Horatio Livermore, as president of the Natoma Water and Mining Company, laid the foundations of the present Folsom dam, about two miles up the stream from the narrow little town that now claims 1,500 people but does not look the part

In 1868 the Legislature awakened from its Rip Van Winkle sleep of ten years and pushed through a resolution requiring that a choice between Rocklin and Folsom be made by the prison directors before July of that year. The Livermores' dam was only partly built, and there was an immense amount of work ahead to complete it and the outflow canal that was to float the logs down to a proposed sawmill near the present site of the power plant. The Livermores met the prison directors and offered big inducements to get the prison at Folsom. Their proposition was accepted.

The Livermores were to give the State 350 acres of quarrying and agricultural land on the east side of the river adjacent to the dam. They were to include with the land a perpetual and exclusive right on the part of the prison to waterpower produced by a fall of five feet. This was to be provided at the end of the first 1,000 feet of canal just before it left State property and resumed its course down to Folsom. In exchange for the land and the waterpower the Livermores, as soon as the prison should be finished, were to get $15,000's worth of convict labor to complete their dam and part of their canal.

In May of 1872 the Livermores filed a claim to a flow of 100,000 miner's inches of water.

The State decided, in 1874, that it would be desirable for the new prison to have some other lands adjoining the original tract, and an additional 134 acres was secured from the Livermores, making a total area of approximately 484 acres.

The prison was not completed till July of 1880. No convict labor could be available until the prison was built.

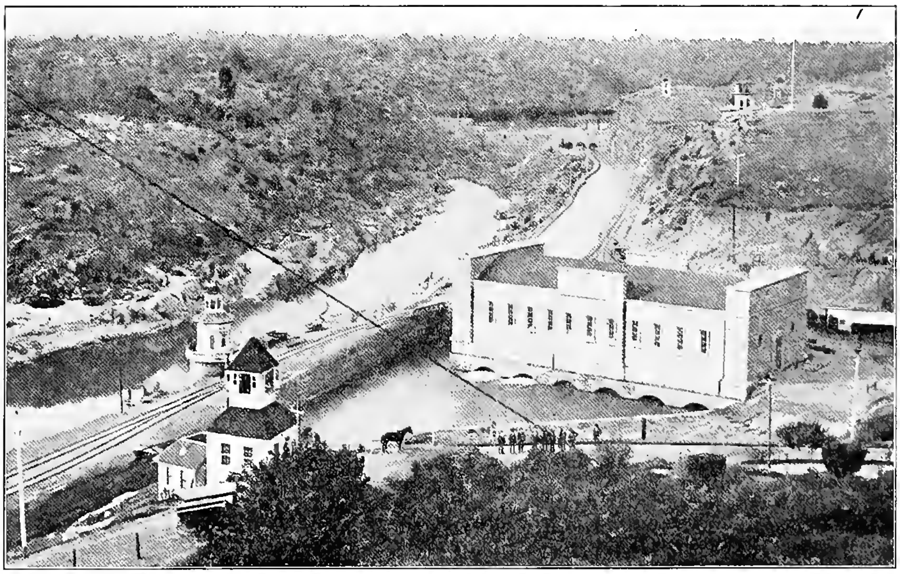
The water company had gone on working and had expended an aggregate of $119,000 in constructing its two-mile railroad from Folsom up to the dam and in laying the foundation of the dam itself. But it had not yet received one dollar in money or an hour of labor from the State in payment for that tract of 484 acres upon which the new prison was standing. For twelve years the company had been waiting for that promised pay in convict labor.

In September of 1881 the Natoma Water and Mining Company became the Folsom Water Power Company, a change of name but not of men chiefly interested. The company then demanded the prison labor due. But in August of 1882 a controversy arose. The company insisted that it was not giving all that land and those waterpower rights for the originally designated $15,000's worth of prison labor. No; there was $30,000's worth of convict labor coming to it. The warden of the prison continued to offer eighty convicts

who would be put to work on the job, and the company just as regularly declined to accept the labor with its implied payment of only $15,000.

The company had stopped work on the dam. The State brought suit to compel the company to accept the convict labor and go on with the construction of the dam and the canal. But the Superior Court decided that the company did not have to accept the labor unless it so desired. Thus matters dragged along until 1888, when Governor Stoneman came into office. Then the Folsom Water Power Company made a new proposition to the State the 5th of May, 1888. The proposition was this: the State should furnish the convict labor necessary to complete the dam and build the canal as far as the mud sink at Robber's Ravine, a distance of about 6,000 feet below the dam, and in consideration of that labor the company would then give the State additional waterpower produced by a

Albert Gallatin, Sr.



Folsom Prison Power House, showing the Pacific Gas & Electric Co.'s Dam upstream and from it the canal along the near bank of the river.

fall in the prison yard of 7.33 feet, instead of the originally designated 5-foot fall; would give the State the right to use the company's railroad line from Folsom up to the prison, provided the State kept the road in repair; would permit the taking or pumping from the canal of all water desired on the prison property for irrigation and domestic purposes; would permit the taking of gravel from the adjacent river bed, which was all owned by the company; would permit ingress and egress over the company's lands on the river side of the prison, and the passage over the company's land of a prison sewer to flow into the river. These rights, aside from the water power, were considered by the prison warden to be worth more than the value of the convict labor desired. He reported to the Governor that the water power alone would produce 800 horsepower, which, at the existing price of fuel, would otherwise cost $64,000 a year to produce and would mean to the State the equivalent of a million-dollar power investment.

The company's new proposition was readily accepted by the State, and the first day of July, 1888, convicts were put to work on the dam and the canal.

H. T. Knight was the company's engineer of construction. Later he started the power plant as its superintendent, a position in which he was succeeded by his son. He had all along been supervising the work on the dam. He continued doing so. The understanding was that the company should supply the granite, the materials, and the engineering plans, and that the State should simply furnish the manual labor. For exactly six years the convicts worked on the dam and the canal. During that time they did an aggregate of 520,349 days' labor, which, valued at 50 cents a day, was equivalent to the payment of $260,174 to the company. In addition to this convict labor, the State provided free labor for which it paid $24,508. This made the total price paid by the State equivalent to $284,682, but the labor was worth to the company many times 50 cents a day.

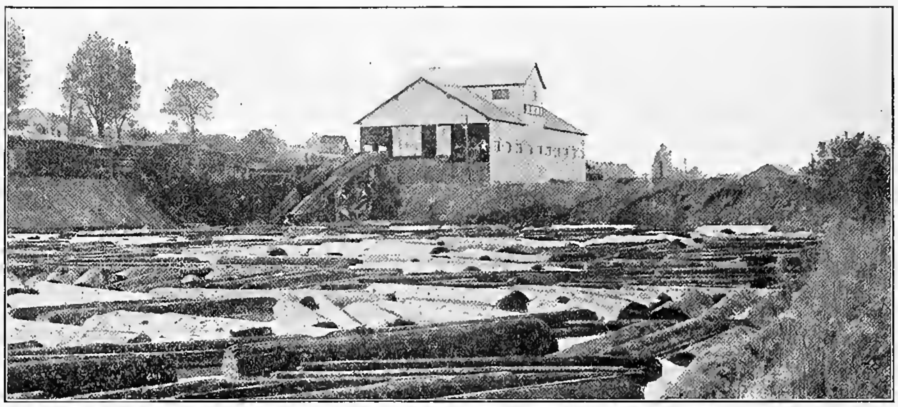
The water was first turned into the Folsom canal and allowed to flow through the prison yard in January of 1893. The prison had built a power house of its own to use the seven-foot fall. The water company had meanwhile completed at its own expense the remainder of the canal.

The original intention had been to have the canal bring logs down to a sawmill at Folsom, and thence to convey the water on for irrigating purposes. This idea had evolved into a plan for having an electric power plant at Folsom that would supply energy to manufacturing enterprises which it was hoped would be established there. But before the dam and the canal were completed long-distance transmission of electric energy became a practical fact. So all those dreams about factories at Folsom went glimmering, and plans were changed to give Folsom a hydroelectric plant, its prime object then being the transmission of energy down to Sacramento. Late in 1892 Horatio Livermore and Albert Gallatin secured a street-car franchise in Sacramento, and November 1st of that year they conveyed the franchise to the Sacramento Electric Power

and Light Company, which later took current from Folsom.

The Livermore brothers were natives of Boston and came to California in the later 50's. Horatio Livermore was the financial manager of their enterprises, and was married. Charles never married, but always made his home with his brother. He embarked in the wholesale drug business in Nevada in the palmy days of the Comstock, and later engaged in quicksilver mining with Horatio. But their chief concern was the development of water power at Folsom. Charles Livermore was at the head of the company when the Folsom plant began operations. He was an ardent lover of athletic sports, established the first rowing club on California waters, and was one of the fourteen original incorporators of the Olympic Club of San Francisco. While not educated for engineering or art, he developed natural talents for these subjects, and was an original member of the San Francisco Art Association. The names of Horatio Livermore and Albert Gallatin are intimately associated with the Folsom enterprise and with the business life of Sacramento more than a generation ago.

Charles E. Livermore, who was president of the Company when the Folsom Plant was started.



Up-stream end of the old Folsom Sawmill.

When the Folsom dam was constructed, water-power under high head was not yet a practical engineering development. By using a very gradual fall of about one foot in every 1000 feet of canal the promoters found they could deliver an enormous flow of water to Folsom at a point about eighty feet above the river bed. From the forebay at the lower end of the canal they could easily secure a sudden fall of fifty-five feet, and that would give them what was then considered considerable power.

They figured that the American river could always be relied upon for an unusually large flow during the dry season. Its numerous branches all have their rise in the Sierra Nevada mountains within a few miles of Lake Tahoe. The heavy snowfall on the ridges there and the late melting of this snow would furnish abundant water late in the season when the effect of the rains had long since waned in other districts. The theory was all right, but the practice did not work out just that way.

The Folsom plant started July 13th, 1895. But its real public inaugural was the day it sent power through to Sacramento for the Native Son's electrical carnival, the 8th of September, celebrating the forty-fifth anniversary of the admission of California into the sisterhood of States.

During the summer of the following year the waterflow in the American river became surprisingly low. Larger demands had come upon the Folsom plant for electricity in Sacramento. What is now the Sacramento Electric Gas and Railway Company had in December of 1895 secured the street-lighting contract by underbidding the old Capital Gas Company for a general reduction of twenty-five per cent, and much other electric business was obtained. Accordingly it became necessary to install a supplementary plant at Folsom, and it was established early in 1897, to develop an additional 750 kilowatts by using the twenty-six-foot fall after the water left the power house on its way back to the river.

In 1896, also, a sawmill was established adjacent to the canal and about a quarter of a mile above the Folsom power house. Logs were floated down the river and then through the canal. Here again trouble arose with the prison authorities. Up to that time the headgates of the canal had been operated from the prison power house. Now the prison refused to raise the gates a little higher to permit the passage of logs. Then arose the questions, Whose dam is that, any way, and who has the right to open the headgates?

In the summer of 1897 the American river got still lower. There was not sufficient waterflow to produce the desired power. It became necessary at Sacramento, from September 22d to October 3d, to shut off current from such large consumers as the Phoenix Mill, the Buffalo Brewery, and the Southern Pacific Railroad shops.

In 1898 the American river dropped still further, and so suddenly that an auxiliary steam plant that was being built at the sub-station in Sacramento for just such an emergency had to be rushed to completion. Even then it was not quite quick enough, because July 17th, the night before it started, the water fell below the top of the penstocks, and the Folsom plant had to be shut down for that evening.

In 1899 a contract was made with the Bay Counties Power Company to secure auxiliary energy the next year from that company's plant, then being built at Colgate on the Yuba river. Meanwhile the series arc lighting system of Sacramento was switched on to the Capital Gas Company's plant, and the steam engine at the sub-station was left to provide the energy for the street railway and such alternating current as its capacity could furnish. With the perfection of the transmission system from the Colgate plant the problem of water storage for Folsom became less alarming, and in June of 1902 John Martin and Eugene de Sabla Jr., the men behind the Colgate enterprise, secured a controlling interest in the Sacramento company and the Folsom plant, though the active management did not change till May of 1904. The control of both the Folsom plant and the Sacramento company became, late in 1902, a part of the system of the California Gas and Electric Corporation, and in January of 1906 it was conveyed to the Pacific Gas and Electric Company.

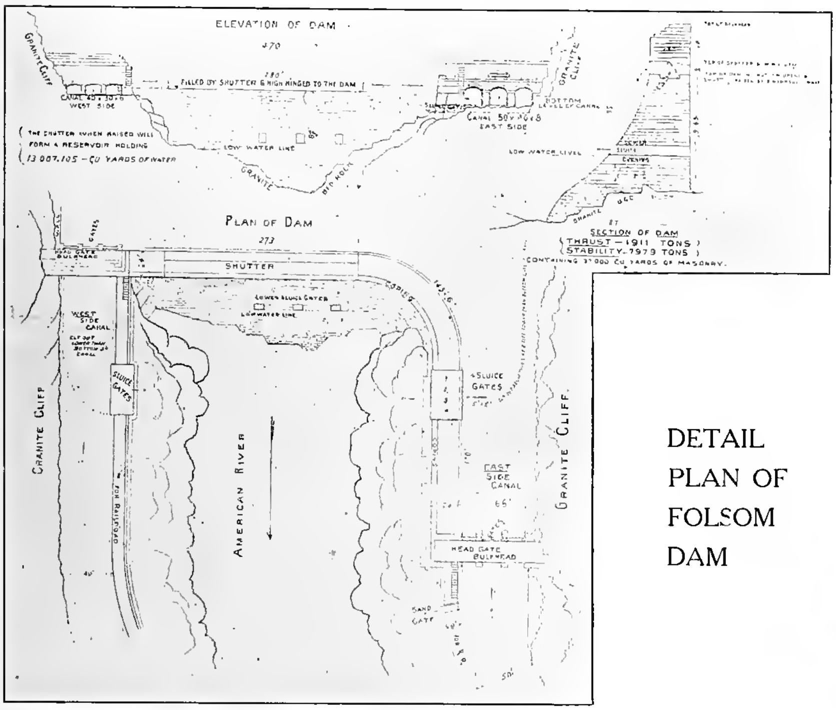
While the Folsom plant receives an enormous flow of water through its canal, the impounding area provided by the dam is not sufficient to maintain that great flow all through the dry season. The fall at the power house is comparatively low, and a tremendous volume of water is required to produce the power.

Carefully made surveys of the catchment area of the American river have indicated that it would be possible to construct in the mountains impounding reservoirs that would permanently increase the flow at Folsom until that flow during the season of least water would be as great as the maximum canal flow now known at the Folsom plant. And the construction of such a system of storage reservoirs would perhaps make constantly available at Folsom 5000 horsepower, where now it is prpoducing from 800 to 1000 horsepower during the lowest flow of the American river.

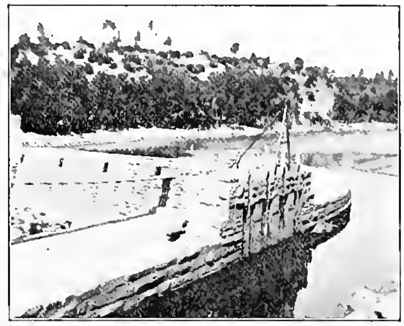
Where the Folsom dam is located the American River narrows naturally between blackened granite bluffs that taper off down-stream into a river bed that for nearly two miles suggests a confusion of solidly made stone walls between which flows the surplus water from the dam.

The dam itself is 81 feet high, 854 feet long, and 16 feet thick at the base.

The elevation of the dam is 210 feet above sea level and 175 feet above the level of the city of Sacramento. It is of solid granite masonry, as may be seen by the accompanying illustrations and the detail drawing. The first intention was to have a canal on each side of the river, but only the east side canal was built. This canal consists of three sections. The first is 2000 feet long, and is cut into solid granite cliffs and walled up on its river side with the granite cut from the cliffs. At the end of this section is the prison power house, a granite structure through which all the water of the canal flows, when it is not purposely diverted to avoid the power house and continue right along down to Folsom. The second section is 4000 feet long, and has its inner side faced with a masonry wall and the outer side protected against the river by heavy riprap work. The first two sections were built by convicts. The third section is 3500 feet long, and was built by the company. It cuts through earth and rock formation, and has an earth and rock fill on the outer edge, which is also



DETAIL PLAN OF FOLSOM DAM



Folsom Dam Across American River, with Outflow to Canal in Foreground.

Downstream Face of Canal Headgates, Showing Massive Granite Bluff at Right.

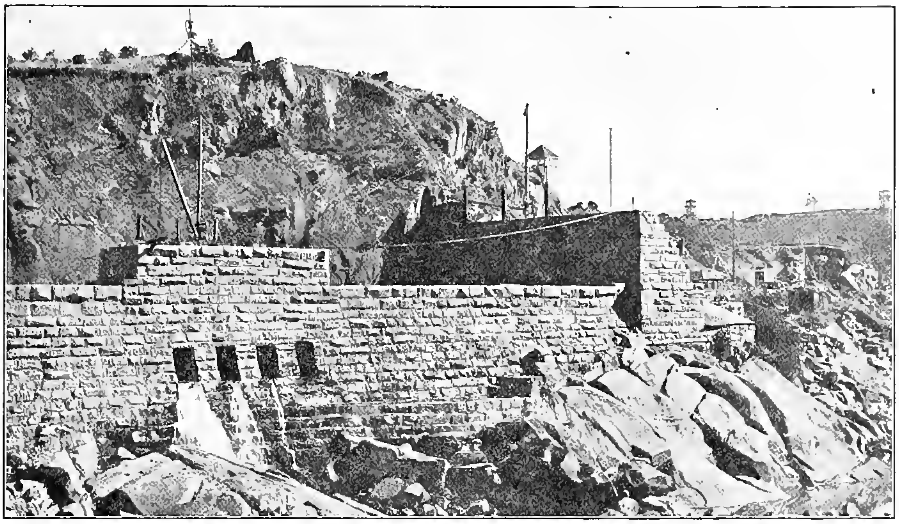
protected in places by riprapping. The total length of the canal is 9500 feet, or almost exactly 1.8 mile. A standard gauge railroad track runs along the canal bank next to the river.

The canal is generally forty feet wide on the bottom, its banks sloping up to give it a width of fifty feet at the top, and the depth is eight feet. At full flow the canal is capable of carrying a constant run of 70,000 miner's inches, or 1750 second-feet, and the plant takes 40,000 miner's inches, or 1000 second-feet at full load.

could just keep his nose above water and float down to safety without being discovered.

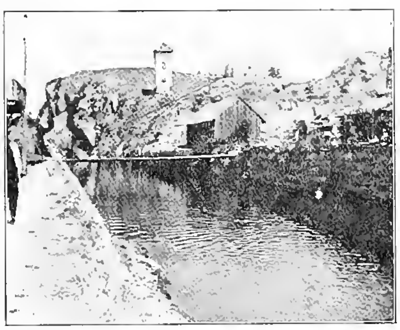
The canal ends in a large granite forebay that is made double by having a granite partition wall dividing it into two sections. This permits one to be cleaned of accumulated silt while the plant is still taking water from the other.

The forebay is 150 feet long, 100 feet wide, and 12 feet deep, and the fall to the turbines is fifty-five feet through four penstocks eight feet in diameter and made of five-eighths-inch steel. Each pair of turbine

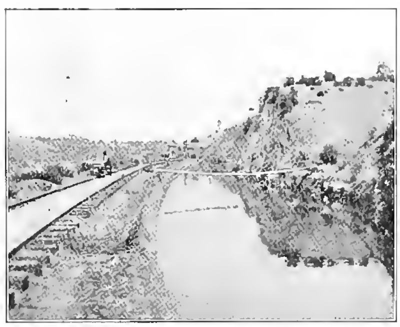


View of Wing Dam and Its Four Sandgates, with Headgates to the Right.

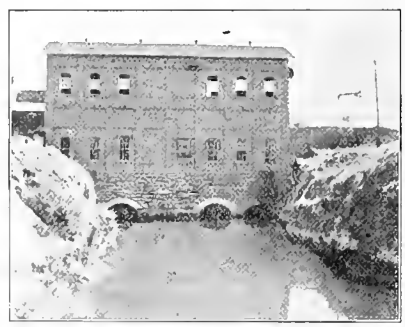
Secondary Plant at Folsom Power Station, Run by Outflow from First.



Looking Up Canal Toward Headgates—Folsom Prison Quarry on Right.



Further Down the Canal, Looking Back Toward Prison Rock Crusher and Watch Towers.



Folsom Power House, with Outflow Canal Through Solid Granite.

Three enormous headgates, each sixteen by fourteen feet in the clear, are situated at the entrance to the canal at the end of the wing dam, and these huge headgates are operated by hydraulic rams, a system which is possible here where there is never snow or ice to interfere. The wing dam is provided, as seen in the illustration, with four sandgates or sluices to carry off sand and prevent its being taken down canal to interfere with the waterwheels in the prison plant. And supplementing these sandgates there is a ledge across the canal itself to catch the sand that may come through the headgates. Below the prison power house are four other sandgates.

Twice convicts have unsuccessfully tried to escape by dropping into the canal, on the theory that a man

wheels is ten feet in diameter. At the time of its installation the hydraulic equipment at the Folsom plant, weighing upward of 400,000 pounds, was considered the most massive and powerful in the world, excepting only the plant at Niagara Falls.

The equipment of the original plant consisted of four S. Morgan Smith turbines, four Lombard governors, and four 3-phase, revolving-armature type, 800-volt, 750-kilowatt generators of General Electric make. There are four transformers, one held in reserve, and their combined capacity is 5000 kilowatts, or 6600 horsepower. The only change from the initial installation is in the transformers, which have been altered to deliver 60,000 volts instead of the original voltage of 10,000.

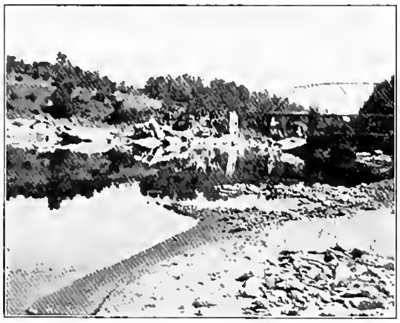
The supplementary, or lower, station at Folsom takes advantage of a twenty-six-foot fall of the water after it leaves the old power house, and there an additional 750-kilowatt unit is installed. It is of the 3-phase, revolving-field type, 11,500-volt, General Electric pattern.

The turbines at the upper power house, under a fifty-five-foot head, run at the rate of 300 revolutions a minute, and are directly connected to the armature shafts of the generators by insulated flexible couplings. Each pair of wheels is supplied with a steel flywheel ten feet in diameter, weighing 10,000 pounds, and having a speed at the outer edge of 9425 feet a minute. Heavy steel rims are shrunk on the wheels to provide for the great strain such speed produces.

The transformers are on the second story of the building. The high-tension leads are led from the transformers to the double pole lines out through a hood-protected opening in the end of the station. The pole line consists of forty-foot, round, cedar poles extending to Sacramento in two parallel lines, one on each side of the county road. From the power house to the railroad station at Folsom the distance is 1056 feet, from the Folsom railroad station to the city limits of Sacramento is 19.4 miles, and from the edge of the city in to the Sacramento sub-station is 1.0 mile, making a total transmission distance of practically twenty-one and a half miles.

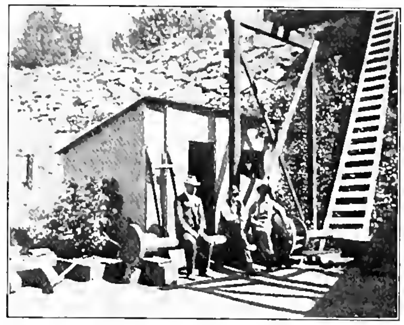
A change was made in the transmission line early in 1905, when the pole line on the south side of the county road was supplied with larger insulators, its wires were given a greater spread, and the potential carried was raised from 10,000 to 60,000 volts.

In the preparation of this sketch the writer acknowledges information obtained from an article published in 1895 by the late George P. Low in the "Journal of Electricity," from C. W. Hutton, an old employe of the Pacific Gas and Electric Company, but now with the Sierra & San Francisco Power Co.; from the report made to the State Board of Prison Directors in 1900 by Warden Aull at the Folsom penitentiary; from some data kindly supplied by United States District Attorney Devlin, who was formerly a prison director and a Sacramento lawyer; and from various employes of the Pacific Gas and Electric Company who have personal knowledge of some of the events as they occurred.

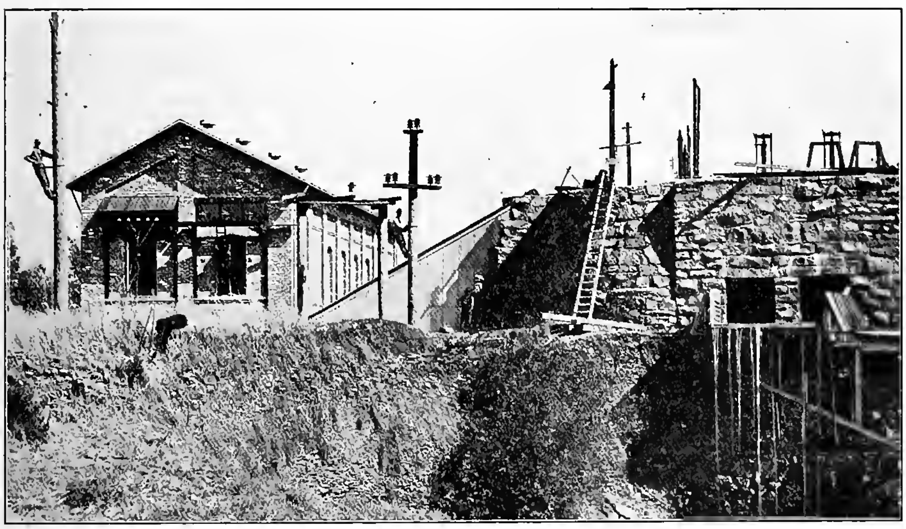


County Bridge Across American River, also Old Stone Abutment that supported first Transcontinental Railroad Bridge.

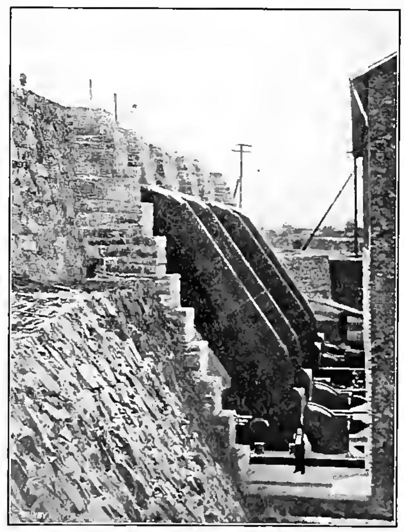
Jacob C. Kearns, who has been at the Folsom Plant ever since the Machinery was Installed.



R. A. Rose, Foreman Frank O. Hutton, and George Ferguson, who has been at the Plant from the start.



Folsom Power House and Granite Forebay.



The Four Penstocks, through which the Water Plunges from the Forebay to the Power Wheels of the Folsom Power.

THE WATT-HOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER I.

GENERAL.

Definition.

The name "recording wattmeter" or "integrating wattmeter," is often erroneously applied. The true name for the instrument commonly used for recording the energy flowing in an electrical circuit for a certain period of time is the watt-hour meter, since it records the product of the watts and the time. The "recording wattmeter" in the true sense of the word is the instrument which is ordinarily known as the graphic, or "curve-drawing wattmeter," which records the watts for any given instant without taking into consideration the time element.

Relation of the Meter to the Central Station.

The relation of the meter and the meter system to the distributing station is a factor of great importance, the gravity of which, as a rule, is not fully realized; especially is this true with the small and the medium-sized lighting and power companies. The revenue of the distributing company depends on the meter in more ways than are at first apparent,and the continued accuracy of its meters is a matter materially affecting its financial success. Inaccurate meters are eventually detrimental to the interests of the company selling current, regardless of whether the meter runs fast or slow. A fast meter furnishes the consumer a very just cause for complaint, and when detected usually reacts strongly against the company in producing mistrust of its methods and a general feeling among its customers that they are paying for something that they never receive. Such a feeling is to be avoided by every possible means, as it causes endless complaints and in many cases the loss of customers with the resulting loss in revenue.

Slow meters, of course, act directly on the company's revenue, failing to record the power which is actually being delivered. This is often a very serious source of loss, especially where meters are operating at light load for a considerable portion of the time, as is almost always the case under commercial conditions. It is this inaccuracy in meters at light loads that constitutes, in the majority of cases, the chief source of loss to the distributing company, and especially is this true where there is no attempt made to periodically test the meters and make any minor adjustments that may be necessary. Meters are often installed under conditions that are by no means the most favorable for a delicate piece of apparatus; this however, is frequently unavoidable, as the meter must be installed wherever power is sold. It is often installed in places which are inaccessable, allowed to become covered with dust and dirt, and in some cases it is placed where it is subjected to severe and continual vibrations; it is usually then left to take care of itself, receiving no further attention than to be read once a month. Under such conditions it is almost inevitable that the meter will eventually run slow, especially on light loads.

In carefully managed and well designed direct current systems, the energy lost in line drop and otherwise unaccounted for between the station bus-bars and the consumer's meters may be as low as 15 per cent, but on alternating current systems, having many small transformers connected to the lines which are continually consuming power in the form of core loss, and with meters which are poorly maintained or entirely neglected, the loss shown by the comparison of the reading of the station meters and the consumer's meters may be as high as 70%. From 15% to 20% represents very good practice on direct current systems, and from 20% to % 30 on alternating current systems.

The Selection of Meters.

The selection of meters is a question which should be thoroughly investigated. While there are several excellent makes of watt-hour meters on the American market, there are still others which may be disastrous to the revenue of the distributing company. It is not always the meter which when new shows itself capable of finer adjustments and consequent high initial accuracy that will prove the most satisfactory or the most accurate after a period of service under average commercial conditions. Of course initial accuracy is an important factor, but it should not be sought at the expense of continued accuracy. The meter should be of as substantial and rugged construction as is consistent with efficient design. Such a meter will prove to be more satisfactory and will show less error after a period of service than will a meter of more delicate construction, although when new it can be adjusted to a finer degree. This question of continued accuracy is of paramount importance and should always be borne in mind while selecting the instrument upon which the revenue of the company is to depend.

Factors Affecting a Meter's Accuracy.

The factors affecting the accuracy of a watt-hour meter are various, but the two principle ones are friction and the weakening of the permanent magnets. If these two factors could be eliminated, a meter once accurately adjusted would remain so indefinitely. Unfortunately, however, these two factors do play a very serious part in the performance of the meter, the most serious being friction. If the friction component was a constant quantity it could be compensated for by the light load adjustment device and thus permanently eliminated as regards the meter's accuracy. It has been found though that friction is an extremely variable quantity and in the case of any motor-meter it may vary by quite a large amount, even under very favorable conditions. For this reason a high value of the torque, or turning effort is very desirable, since with a high torque the percentage of this torque required to overcome any increase in friction is relatively small, and the percentage increase of effective torque due to any decrease in friction is also correspondingly small. Thus it will be seen that a meter having a high torque will not suffer in accuracy nearly so much for the same amount of change in friction as will a meter of low torque. There is, however, a value for the torque, which if exceeded, will result in poor economy, because by increasing the losses a higher value of torque can be produced. It can therefore be readily seen that the design of a meter should be

such that this ratio of torque to watts loss will be at the most economical point.

Since friction is the most serious factor affecting the accuracy of a watt-hour meter, it is essential that every care and precaution be taken both in the design and the manufacture to insure low initial friction, and to insure as far as possible against changes in friction after the meter has been in service for some length of time. Friction will develop in the lower jewel bearing, in the upper bearing and in the recording mechanism.

The Jewel Bearing.

In order to obtain low friction in the jewel bearing the revolving element should be light in weight; only the highest grade of jewels should be used, and they should be carefully selected and ground. The pivots, or the bearing points, should be of the finest grain of glass-hardened steel. It is usual practice of manufacturers to mount the jewel on a spring support, thus taking up any sudden vibrations and thereby preventing excessive pressure between the jewel and the bearing point, therefore prolonging the life of each. Although the actual weight supported by the lower bearing is small, the pressure between the jewel and the pivot in a meter is great, since the actual contact area is exceedingly small, being as it is, almost a "point" contact, so that the pressure per square inch of contact reaches an extremely high value. It is for this reason that jewels of the best quality and "glass-hardened" steel pivots are necessary in the construction of the lower bearing, as any other material would quickly break down and develop excessive friction. The otherwise objectionable "point" contact between the jewel and the pivot is necessary in order that low initial friction may be secured.

Recording Mechanism.

When properly and carefully made, the recording mechanism is not subject to the variations in friction which occur in the bearing, and it can therefore be much more completely compensated for by means of the light load adjustment device of the meter. Only machine cut gears should be used in the construction of the recording mechanism, and during the course of manufacture every precaution should be taken to see that the gears and their bearings are in perfect condition and free from all burrs; even the slightest burr or imperfection in the individual gears will prove to be a source of friction variation, and as some of the gears move very slowly and as friction variation would only appear when the imperfect portion was in mesh, the only feasible way of detecting and preventing this source of future error in the meter is by rigid factory inspection of all parts which enter into the construction of the recording mechanism.

Weakening of the Permanent Magnets.

The next important factor affecting the continued accuracy of the watt-hour meter, and one of a very serious nature, is the weakening of the permanent magnets, often called the "retarding magnets." The only insurance which the purchaser has against a poor grade of permanent magnet is the ability and the experience of the manufacturer. It sometimes happens that meters, especially for switchboard service, are installed where they are subjected to the influence of powerful "stray fields" which may be set up, due to the proximity of wires or bus-bars carrying heavy currents. To nullify the effects of such stray fields on the retarding magnets, some manufacturers arrange the magnets astatically, that is, they are placed so that any stray field which will tend to weaken one magnet will correspondingly strengthen another, and vice versa.

Creeping.

Under the same category as fast meters comes the "creeping" of meters. It is sometimes found that meters will run slowly, or "creep" when there is no current flowing in the series fields, the potential circuit alone, being energized. This is due to the light load adjustment exerting more than enough torque to overcome the friction, and may be due to one or more causes. The light load adjustment may be so set that it just compensates for the initial friction and the meter then installed where it is subject to continual vibration, under which condition, the "friction torque" is reduced and the meter will creep. Again, the meter may be on a circuit where the voltage is above normal, which will tend to produce creeping. As a general rule, meters are so adjusted at the factory as to allow for a range of several per cent in voltage without causing creeping; such practice is to be recommended, as the slight benefit to be derived from having the friction completely compensated for is more than counterbalanced by the trouble due to creeping when such fine adjustments are made.

Overmetering.

Another frequent and easily avoidable source of loss to the distributing company is "over-metering." It often happens that in the case of public buildings, theaters and other places where there is a large "connected" load, and where for a greater part of the time only a small part of this connected load is actually taking current, that one large meter of sufficient capacity to take care of the entire installation is employed. When this is done the large meter will operate the majority of the time on light load, and for a considerable portion of the time it may be operating on very light loads, and since no commercial meter can be relied upon to continuously record such light loads with the same accuracy as at or near full load, there will result a considerable loss from the practice of "over-metering." It is often much better to install a smaller meter to take care of such loads, even at the risk of an occasional burn-out. Practically all standard meters will carry a considerable overload for short periods, and will carry as much or more than 25% overload continuously when located in cool, dry places. It is not recommended that meters be worked at overloads continuously, but in many instances it will be economy to have them work at overloads during the period of maximum demand. By exercising a little judgment a meter can be so selected that it will never be excessively overloaded, but which will be small enough to give a fair degree of accuracy during the light load period.

Where the ratio of the connected load to the average actual load is large, it is better to subdivide the

circuits and install two or more meters than to attempt to handle the entire load on one meter. In this way it can be so arranged that while there is no danger of a meter being severely overloaded, it will still be small enough to accurately record the power during the light load period.

General Construction.

The different types of meters will be dealt with separately hereafter, therefore we will take up at this point the various parts which are common to all types.

Frames and Covers: The supporting frames to which the mechanism is secured should be rigidly constructed from a mechanical standpoint, and the material used should be non-magnetic. The covers should be of sufficient rigidity to protect the meter from ordinary mechanical injury, and should also be light; the composition known as "white metal" is a good material,

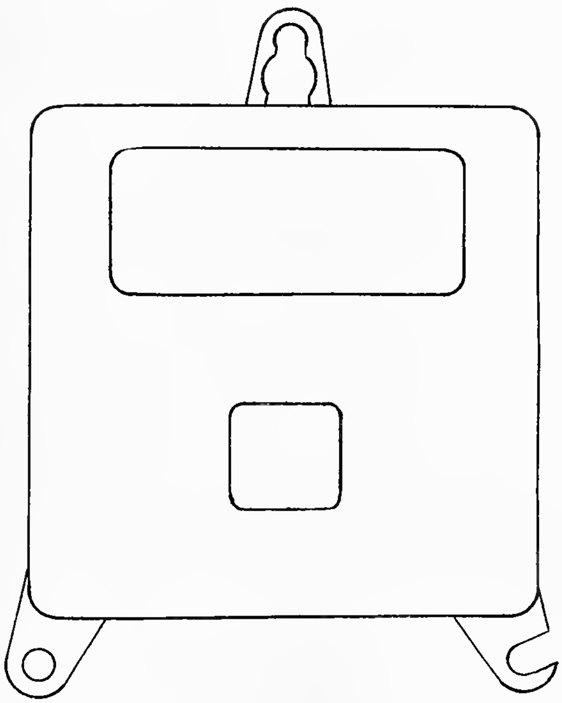


Fig. 1. Supporting Lugs of Base Frame.

being used either in its natural finish or with a coating of dull black japan. In some cases glass is used for the covers so that all working parts of the meter may be superficially inspected without removing the cover. For switchboard meters, glass is a satisfactory material for the covers, but for ordinary house type meters the metal covers are to be recommended; glass covers, exposing all parts of the interior to view, may tend to invite tampering by unauthorized persons. The internal frame which actually supports the bearings and other parts of the meter proper should also be made of non-magnetic material. In the ordinary type of "commutating" meter the construction of the internal frame is such that when used on alternating currents it is often the case that heavy eddy currents may be induced in the frame by the rapid reversals of the "projected" field. Such eddy currents cause undue heating, and to obviate this some manufacturers split the frame and insert a piece of fibre or other insulating material.

The base frame is usually furnished with three supporting lugs as shown in Fig. 1, the top lug being key-holed and the lower right hand one slotted, thus allowing the meter to be rapidly hung in place. It can then be properly levelled and set and the supporting screws driven home.

The removable covers are usually held in position by two or more studs which are fastened to the base frame and which project up through the covers; wing-nuts having holes through their bodies, through which seal wires may be passed, are used on the studs to securely hold the covers in place. The groove in the base frame into which the covers fit, should be provided with felt gaskets to exclude dust, moisture and insects from the interior of the meter. The holes for the entrance and exit of service wires should also be provided with a dust proof feature, and the dial window should be set in putty or other suitable material.

The Top Bearing: The top bearing of a meter is necessarily simple, as it does not have to support any weight, but simply acts as a guide bearing, and may be the same as or similar to either of the two types shown in Fig. 2.

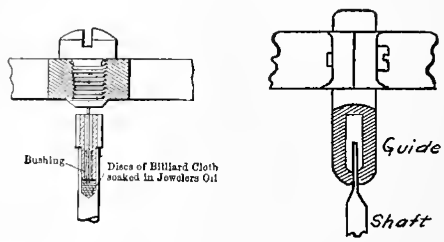


Fig. 2. Types of Top Bearing.

The Shaft: The shaft should be made as light as is consistent with good design, and is usually made of steel approximately ⅛-in. in diameter, some manufacturers using a solid shaft, and others a tubular form. At the top of the shaft is mounted the "worm" gear which transmits the motion of the shaft to the recording mechanism. There are two general methods of constructing the worm; one consists of cutting it directly into the steel shaft, the other method being to mount a worm of composition material in the end of the shaft. This latter method possesses the advantage of allowing the use of a non-rusting material. On the lower extremity of the shaft is mounted the removable pivot.

Discs: Until several years ago, the meter discs were made almost exclusively of copper on account of its high conductivity, but aluminum has practically superseded copper for this purpose, due to its lighter weight. An aluminum disc having the same conductivity as a copper disc will weigh only about 48% as much as the copper. Therefore the aluminum, though of greater thickness, is much more desirable. The question is often asked: "Why are most meter discs roughened or covered with little holes which resemble prick-punch marks?" This has nothing whatever to do with the electrical characteristics of the meter, as is sometimes supposed, but simply results from a factory method of producing a plane surface. The disc is placed on a heavy metal block, and a weight having a roughened surface is allowed to fall upon the disc, thus producing the peculiar marking. It has been

found that this process eliminates any trouble which may be due to the warping of the disc.

The Lower Bearing: There are at the present time two general types of lower bearings in use; the pivot and jewel type as shown in Fig. 3, and the ball and jewel type as shown in Fig. 4. The ball bearing is relatively a new departure, but in reality it is essentially a "pivot" bearing also, and as far as the comparative friction is concerned, they are, it is safe to say, about equal. So long as the ball remains perfectly smooth and free from rust it serves its purpose admirably.

Jewels: It has been found that there are but two kinds of jewels which are satisfactory for use in the lower bearings of meters, they being the diamond and the selected eastern sapphire. In self-contained meters, up to and including 50 k. w. capacity, the

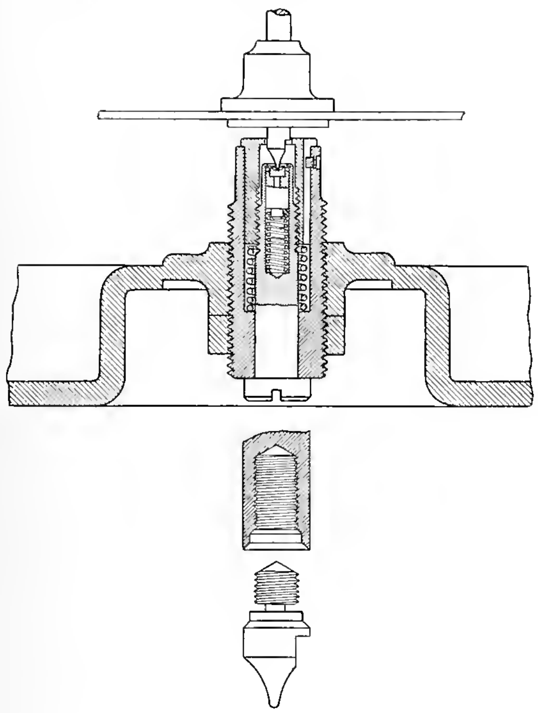


Fig. 3. Pivot and Jewel Type of Lower Bearing.

sapphire is generally used to the best advantage; above this value, on account of the greater weight of the moving element, it is advisable to use the diamond, because of its unequalled hardness. Where great accuracy is desired in the case of switchboard meters in central stations, it is often desirable to use diamond jewels in meters of as small a capacity as 5 amperes. In all cases, the jewel should be carefully selected, ground and polished, and should be free from all flaws. It has been noted that under normal conditions, the average sapphire jewel will stand as much or more than 600,000 revolutions of the shaft, and in some cases the diamond jewel has lasted for as many as 35,000,000 revolutions of the shaft. These values, however, are extremely variable and depend to a great extent upon the conditions and care under which the meter operates.

The Retarding Magnets: It is of the utmost importance that the strength of the retarding magnets be as permanent as is possible to make them, since their retarding or "dragging" effect is proportional to the square of their magnetic strength. Therefore a slight change in the strength will have an appreciable effect upon the speed of the disc. Much depends upon the physical properties of the steel from which the magnets are manufactured, and the most rigid inspection, by both chemical and physical analyses should be made of each lot of steel before it is treated for use as meter magnets. The manufacturer, after he has given the steel a special process of treatment, hardens, forms and magnetizes the product. The completed magnet is then subjected to hammer blows to detect any mechanical imperfections, and if it should fail to "ring true" is rejected. It then undergoes an artificial aging process; accurate measurements of magnetic strength being made at frequent intervals. It is then laid away for several months after which

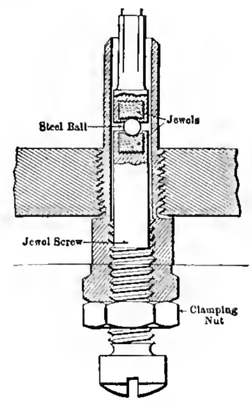


Fig. 4. Ball and Jewel Type of Lower Bearing.

the strength is again measured and if this latter measurement differs in the least from its strength when first laid away it is discarded.

A very successful process of magnetizing meter magnets consists in slipping the completed form over a copper bar, through which a heavy current of electricity (many thousands of amperes) is passed momentarily. In this way a great number of forms can be magnetized at the same time, and a uniform strength produced. Great care is taken in the manuture of the permanent magnets, and as a rule the results are very satisfactory.

The Recording Mechanism: As previously pointed out, the recording mechanism should be manufactured with the greatest care, and rigid factory inspection is practically the only safeguard against imperfections. Meters are often placed in such positions that the meter reader will encounter reflected light, and for this reason it will generally be found that a dial of unglazed material will be less difficult to read under all conditions. The recording mechanism should be so constructed and provided with such dowel pins that it can be removed from the meter at any time and then replaced in the exact position from which it was originally taken without disturbing in the least the mesh of the worm with the first gear.

From the foregoing description of the general construction, a very good idea can be gathered as to the mechanical requirements of a good meter; a study of the subsequent chapters treat of the electrical characteristics.

(To be continued.)

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Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

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CONTENTS

Patent Office Reform

Rumors are rife as to reform in the Patent Office. Inventors, manufacturers and capitalists agree that some change is necessary to eliminate existing uncertainty as to the validity and scope of patents granted. Under present conditions no patent can be considered binding until it has been finally passed upon by the courts. This involves vexatious and costly litigation, and contravenes the primary intention of the patent laws that invention should be encouraged.

The efficiency of the Patent Office closely concerns commercial progress and any remedy that facilitates finality of patent decision advances our industrial welfare. Among the many causes assigned for American success, not the least is the characteristic habit of crystalizing imagination into invention. The United States Patent Office will soon grant its millionth patent, the annual crop now being close to forty thousand. In 1909 the proverbial ingenuity of the Connecticut Yankee gave this State the first place in the per capita inventive output, there being one invention for every 881 inhabitants. It is significant that, except for the District of Columbia, the Western States of California, Washington, Nevada and Colorado are, respectively, next in order. Oregon and Utah are twelfth and fourteenth in the list. South Carolina has but one inventor to every 19,424 inhabitants.

From the report of the Commissioner of Patents for 1909 we also learn that he is keenly aware of the defects in the patent system as it is. His criticism is constructive in that it contains certain recommendations for betterment. Less than one-half of the listed patents have been properly classified and the examiners have difficulty in definitely determining the novelty of the new inventions. The Commissioner urges that the inadequate force now available for this work be augmented so that it can be quickly completed.

The Commissioner furthermore recommends the abolishment of the present dual course of appeals, with its attendant delay and expense, and the substitution therefor of a measure giving jurisdiction to a single appellate tribunal, from which further appeals can be carried to the Court of Appeals of the District of Columbia. He also endorses the efforts of the American Bar Association to establish a Court of Patent Appeals in lieu of the latter. Bills to this effect are now before Congress.

Commissioner Moore also suggests the repeal of the law relating to caveats on the ground that it gives no real protection against infringement. The advantages that do accrue under the caveat provision are among those embraced by filing an application for patents. His final plea for more commodious quarters for the patent office is one that should be granted, especially as this department is one of the few that are run at a profit and can be well housed by expending the seven million dollars that it has turned into the Treasury since its establishment.

PERSONALS.

M. M. O'Shaughnessy is in Southern California on hydraulic engineering business.

Mr. Ralston of the Ralston Electric Supply Company of Albany, Ore., was a recent visitor in San Francisco.

Frank Dabney has been appointed controller of the Seattle Electric Company and subsidiary companies at Seattle, Wash.

F. L. McGillan, manager of the California Pole & Piling Company, left San Francisco last week on a trip to Everett, Wash.

T. B. Hunter, president of the Monterey Water Company of Monterey, Cal., was a visitor in San Francisco during the past week.

R. B. Elder, district manager of the Allis-Chalmers Company, has returned to San Francisco from a business trip to Los Angeles.

C. O. Poole, who was for some time engineer for the Nevada-California Power Company, was in San Francisco from Los Angeles this week.

H. Krantz of the H. Krantz Mfg. Company of Brooklyn, N. Y., is visiting the Pacific Coast offices of the company, Otis & Squires of San Francisco.

A. D. Miller, formerly manager of the Reno Traction Company of Reno, Nevada, has been made manager of the Central California Traction Company of Stockton.

H. H. Manley, who is connected with the management of the Crescent City Light, Water and Power Company at Crescent City, Cal., is a visitor in San Francisco.

F. W. Siemon, treasurer of the Westinghouse Electric & Manufacturing Company, of Pittsburg, has gone to Portland, Ore., after spending several days in San Francisco.

K. G. Dunn, engineer, of Hunt, Mirk & Co. of San Francisco, is in the Northwest on business connected with the Westinghouse Machine Company's steam turbine line.

W. P. Hammon, president of the California-Nevada Electric Power Company, with offices in San Francisco, has gone East on business connected with his large water power and mining interests.

A. W. Q. Birtwell, assistant treasurer of the Tacoma Railway and Power Company, and the Puget Sound Electric Railway, Tacoma, Wash., has been appointed assistant treasurer of the Seattle Electric Company.

George C. Graham, formerly master mechanic of the United Traction Company, of Albany, N. Y., is now superintendent of car equipment and shops of the Los Angeles-Pacific Company, Los Angeles, Cal.

George Henry, Jr., engineer with the Pelton Water Wheel Company's San Francisco office, has returned from a trip through the Pacific Northwest where he found good business conditions in engineering lines.

Francis Hodgkinson, chief engineer of the turbine department of the Westinghouse Machine Company of Pittsburg, is in San Francisco from the East via Portland. This is Mr. Hodgkinson's first visit to the company's San Francisco office. He will soon visit Los Angeles.

W. E. Wilmot, formerly auditor of the Seattle Electric Company, has been appointed assistant treasurer of the Puget Sound Electric Railway and the Tacoma Railway and Power Company, Tacoma, Wash., to succeed Mr. A. Q. W. Birtwell, who has been appointed assistant treasurer of the Seattle Electric Company.

James M. Wakeman has resigned as vice-president of the McGraw Publishing Company, of New York City, in order to take a needed rest. He has been succeeded by Hugh M. Wilson, formerly publisher of the Electric Railway Review.

C. L. Cory, electrical engineer, read a paper on "The Public Service Corporation" at the monthly meeting of the American Institute of Electrical Engineers, held February 25th in the Home Telephone Building in San Francisco. An interesting discussion of the subject by members followed.

Delos A. Chappelle, general manager of the Nevada-California Power Company, was in San Francisco this week, with his consulting engineer, C. O. Poole, of Manifold & Poole, of Los Angeles, closing contracts for the electric equipment of a new power-house on the Bishop Creek development in Nevada.

Bertram M. Downs, vice-president of the Brookfield Glass Company of New York City is looking over Pacific Coast conditions, leaving San Francisco this week for Seattle. Mr. Downs reports that this company has a large reserve stock to care for the great increase in business which Eastern demand shows is impending.

TRADE NOTES.

The Westinghouse Electric & Manufacturing Company has secured the contract for the electric motor equipment for a gold dredge.

The John R. Cole Co. of San Francisco have opened up a branch office at Los Angeles at 221 Grosse Building, in charge of Geo. A. Cole.

The Pelton Water Wheel Company of San Francisco has closed a contract for two 600-h. p. turbine wheels for the Yuba Construction Company. These will be direct connected to generators which will furnish current for the operation of a gold dredge which is to be built in Colombia, where the Yuba Company has mining interests.

Hunt, Mirk & Co. of San Francisco during the past week sold the Los Angeles Gas & Electric Company an additional Westinghouse-Parsons turbo-generator, rated at 4000-kw., 60 cycles. The company already has in operation a 3000-kw. generating set of the same make. Additional boilers and auxiliary apparatus are yet to be contracted for.

The H. Mueller Mfg. Company of Decatur, Illinois, have established an agency in California, with Mr. C. D. Saunders as manager. He will be located in San Francisco. Mr. Saunders' territory will include California and Nevada. It is contemplated, at a later date, to establish a branch house in San Francisco for the convenience of the western trade.

The Westinghouse Machine Company has sold an additional 1500 k. w. 2300 volt 2-phase 60 cycle Westinghouse-Parsons turbo-generator to the Hawaiian Electric Company for use in the Honolulu central station. Both lighting and power services are supplied. The 750 k. w. Westinghouse-Parsons turbo-generator set that was supplied some time ago gave such satisfaction that the present order was given.

The General Electric has just sold the Yuba Construction Company complete electrical equipment for a big gold dredge of 300 h. p. digger-capacity, which is to be built and operated near Boise City, Idaho. The list of 200-volt induction motors to be supplied is as follows: One 300-h. p. digger motor; 150-h. p. high-pressure pump motor; 75-h. p. low-pressure pump motor; 25-h. p. auxiliary pump motor; 75-h. p. sand pump motor; 75-h. p. stacker motor; 35-h. p. winch motor. The contract also calls for one 2-h. p., 110-volt tool motor, two 7½-kw. lighting transformers and a 7-panel switchboard, with the necessary cables to connect the dredge with the power line.

NEWS OF THE STATIONARY ENGINEERS

PREAMBLE.—This Association shall at no time be used for the furtherance of strikes, or for the purpose of interfering in any way between its members and their employers in regard to wages; recognizing the identity of interests between employer and employe, and not countenancing any project or enterprise that will interfere with perfect harmony between them.

Neither shall it be used for political or religious purposes. Its meetings shall be devoted to the business of the Association, and at all times preference shall be given to the education of engineers, and to securing the enactment of engineers' license laws in order to prevent the destruction of life and property in the generation and transmission of steam as a motive power.

California.

No. 1. San Francisco, Thursday, 172 Golden Gate Ave. Pres., P. L. Ennor, Sec., Herman Noethig, 816 York St.

No. 2. Los Angeles. Friday, Eagles' Hall, 116½ E. Third St. Pres., J. F. Connell. Cor. Sec., W. T. W., Curl, 4103 Dalton Ave.

No. 3. San Francisco. Wednesday, Merchants' Exchange Bldg. Sec. David Thomas, 439 Merchants' Exchange Bldg.

No. 5. Santa Barbara. Geo. W. Stevens, 2417 Fletcher Ave., R. R. No. 2.

No. 6. San Jose. Wednesday. Pres., W. A. Wilson, Sec., Lea Davis, 350 N. 9th St.

No. 7. Fresno. Pres., A. G. Rose. Sec., E. F. Fitzgerald, Box 651.

No. 8. Stockton. Thursday, Masonic Hall. Sec., S. Bunch, 626 E. Channel St. Pres., H. Eberhard.

Oregon.

No. 1. Portland. Wednesday, J. D. Asher, Portland Hotel. Pres., B. W. Slocum.

No. 2. Salem. A. L. Brown, Box 166.

Washington.

No. 2. Tacoma. Friday, 913½ Tacoma Ave. Pres., Geo. E. Bowman. Sec., Thos. L. Keeley, 3727 Ferdinand St., N., Whitworth Sta.

No. 4. Spokane. Tuesday. Pres., Frank Teed. Sec., J. Thos. Greeley, 0601½ Cincinnati St.

No. 6. Seattle. Saturday, 1420 2d Ave. Pres., H. R. Leigh. Sec., J. C. Miller, 1600 Yesler Way.

Practical letters from engineers and news items of general interest are always welcome. Write your items regardless of style. Communications should be addressed to the Steam Engineering Editor.

PRACTICAL MECHANICS.

Paper No. 8.

Transmission of Pure Rotation by Means of Belts and Ropes—In this paper we shall consider the case of transmission by wrapping connectors on belt gearing. This is one of the most important forms of mechanical power transmission. It is reliable, simple, comparatively inexpensive, and capable of extension to considerable distance between driver and follower. It also lends itself to a variety of different applications; so much so that it is probably our most useful form of mechanical transmission.

In this classification are included belts, bands and chains working over either pulleys or sprocket wheels for continuous motion, and over cams also where the motion is limited. Where the motion is not continuous the velocity-ratio may be either constant or variable. The applications of variable-ratio belt transmission are not of sufficient importance to be of interest to the engineer and will therefore be passed over with the general statement: The velocity-ratio is always equal to the inverse ratio of the segments of the line of centers; counting from the centers of motion to the intersection with the line of action—that is the belt or rope. In Fig. 9 this may be stated $\frac{\omega_b}{\omega_a} = \frac{BC}{AC}$ where ω_a and ω_b are the angular velocity of A and B respectively. This will be equally true if c falls between A and B as it would do in the event that the belts crossed and the directions of rotation of driver and follower were opposite. The velocity ratio may aso be determined from the ratio of the perpendiculars AD and BE drawn from the centers of rotation to the line of contact; thus $\frac{\omega_b}{\omega_a} = \frac{BE}{AD}$ This is of course obvious from the similarity of triangles. In practice, where a given shaft is to be driven by belt from a driving shaft of known speed, a definite belt speed is determined by a knowledge of the power to be transmitted, the distance between shafts, and such other conditions as exist to affect the belting. The belt speed and revolutions per minute being known, the pulley diameter is easily found by the formula: Belt speed in feet per minute equals revolutions per minute times the circumference in feet or $V = \frac{\text{r. p. m. } \pi D}{12}$ from which $D = \frac{12\ V}{\pi \text{ r. p. m.}}$

If the driving pulley and speed of the driving shaft are given the size of pulley necessary to give a certain speed to the driven shaft may be found by direct proportion. Thus in Fig. 9 Diameter of B x speed of B equals diameter of A times speed of A. That is, the product of diameter into revolutions per minute is constant.

Taking up now the constant velocity-ratio we shall consider the three cases of axis relation as has been done heretofore.

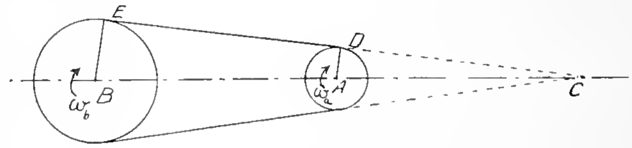


Fig. 9.

1—Axes of rotation parallel either in the same straight line or otherwise.

Where the axes are in the same straight line and their regular velocities are the same, the direct coupling is to be preferred to any other form of transmission; but if a different velocity ratio is desired then belting and a counter shaft with two pulleys could be used. As this would then become a case of parallel axes not in line we shall consider that condition at some length.

Ordinary Belting—The belt may be either a leather strap or a woven texture with a rubber filling; or a series of links connected with pins. Belts are flat or round. The latter being often employed for small work. If other than flat the belt runs in a groove of *V* shape. The usual belt for power transmission is flat, however, and runs on nearly flat pulleys, a slight double cone surface being given them to assist in keeping the belt centered. A belt will always try to climb to the highest point, or to the greatest diameter, and hence the center crowning attracts both sides of the belt to it and so keeps it on the pulley.

The exact velocity-ratio where fairly thick belting is employed is hard to be found for two reasons. The belt thickness adds appreciably to the pulley diameter and the unavoidable elasticity of the belt—its contraction on the driving pulley and expansion on the driven pulley causes an apparent slip. It is this creeping action that keeps the surfaces of pulley polished.

PROBLEMS DISCUSSED BY CALIFORNIA NO. 3. N. A. S. E.

BOILER SETTINGS.—Has reinforced concrete ever been used for boiler setting, and if so how does it compare with brick? How does the cost compare?

Concrete has not been used for a complete boiler setting because it will not endure the high temperature to be met. Under such extremes of temperature as are met in boiler settings it will soon disintegrate and actually crumble to dust. This is due to the expansion and contraction as well as to a deterioration in the cement. Reinforced concrete would be as expensive if not more so than brick. A fire brick lining would be required in any event and reinforcement would be necessary.

PACKING.—What is the advantage if any of cutting packing on a bevel rather than square across?

There is no appreciable advantage. It may result in preventing leakage at the joint but as each ring "breaks joints"

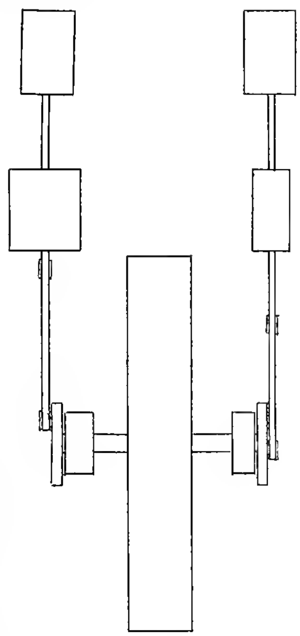
with the others this is not important. It would be easier to insert a packing ring so cut.

INDICATOR PIPING.—What is the advantage of having two indicators with the consequent short piping to each, over a single indicator with the usual three-way valve and double piping to it?

Where a single indicator is used there may be a slight displacement of the card due to the slight lag of the steam in traversing the long piping. The card itself would not be distorted but might be shifted along the sheet slightly so that a longer clearance than actually existed would be shown.

Where the load is varying greatly there may be a decided change in the performance during the interval between taking the two cards on a single indicator where, with two indicators, the cards could be taken approximately simultaneously and thus the true load at any instant would be obtainable.

FLYWHEEL.—In a direct connected cross compound pumping engine as shown in the attached cut what is the function of the flywheel?



The fly wheel in this case acts as a regulator on the speed holding the angular velocity constant at all parts of the revolution. Thus at the beginning of the stroke the initial steam pressure in the h. p. cylinder is greatly in excess of the hydraulic pressure opposing it. At this part of the stroke then the fly wheel is storing up energy. Out on the expansion line there is a point where the above two pressures are equal and opposite. Here the flywheel commences to return its energy back to the shaft. Of course the L. P. cylinder would be exciting energy when the h. p. were on the low end of the expansion line but the variation in available surplus energy would be considerable in the absence of the flywheel. That the flywheel actually does cause a continually varying supply of energy to be transmitted into and out of the shaft is evidenced by the very pronounced wear on one side of the crank pin. At the beginning of the stroke the pin receives the thrust from the connecting rod and later when the fly wheel returns that thrust the crank has so turned that the same side of the pin now receives the pull. It is thus worn out of round in this spot. Flywheels have been known to creep on the shaft during portions of the revolution and could only be prevented by heating the hub bolts and setting them up white hot so that their contraction gave enormous gripping to the shaft.

CO-OPERATIVE CO-OPERATION.

BY ANDREW CARRIGAN.

In a treatise on co-operation, from our standpoint, we must choose from its various definitions the following: "Joint action"; "a working together," as derived from verb "co-operate"—"to work together for a common end." As a synonym of "co-operation," we find the word "aid" and its definition "to promote the success of." The word "aid" has many definitions and many synonyms, but we have selected this one rather than the broader term "help," as this might be construed in a charity sense that would be repugnant to every self-reliant American business man.

Co-operation, being a joint action, almost invariably follows a condition of necessity; this necessity may be political, fraternal or financial. The present discourse is certainly not political; it undoubtedly is financial, but I hope, above all, that we can call it fraternal, for business is cold enough at its best, and a touch of fraternity goes far indeed to add a pleasure to the everyday routine of an everyday business life. As to the necessity of co-operation, stop and consider the business conditions of today as compared with twenty to thirty years ago. Then, co-operation was as unknown as it was unnecessary. Competition was limited, and on the Pacific Coast was largely confined to "Have you got the goods?" not "What is your price?" In those days, the personal equation in business counted far more than now, so that of necessity we must adopt the "live and let live" idea, and that idea is born of co-operation. This does not mean co-operation; it means nothing in the restraint of trade, but it means only the development of a higher business ideal, the curbing of our business jealousies; above all, it means competition on a higher plane. All of this refers particularly to those of us who are competitors. We are then led to the subject of co-operation between jobbers and manufacturers or their representatives, and between the jobber and the retailer or contractor. Time and custom have evolved the most economical channel of distribution, namely: first, the manufacturers who create, each in himself, a limited line of commodities, too limited for economical distribution to the retailer or consumer; second, the jobber who stocks the various lines of many manufacturers, and, third, the retailer or contractor who draws from such assembled stocks and sells to the consumer, whether in the remote country places, or to the householder in the towns and cities, and with whom the jobber or manufacturer cannot come in contact.

While co-operation may not be essential to the mere existence of any of these classes, it is certainly essential to their success and happiness, and we are all entitled to our fair share of those commodities in life.

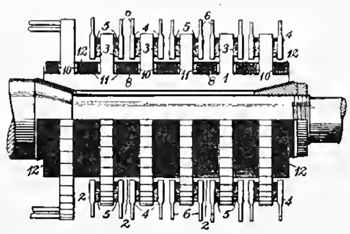
Thus far we have dealt with the cause and necessity of co-operation, and we come now to the resultant action of co-operation, which may be defined as reciprocity and the final result of all success. To reciprocate is "to give and take mutually"; also, "to give something in return for." Reciprocity with its "give and take" motto must be our keynote; we cannot "have our cake and eat it too"; we cannot hope to be "all things to all men." Let us endeavor, then, to "live and let live," each in his own sphere of action, to the end that success, that for which we all strive may be ours.

G. E. 210 RAILWAY MOTOR.

Bulletin No. 4715, recently issued by the General Electric Company describes the company's G.E.-210 Railway Motor. The motor is a 70 h. p., 600 volt motor of substantial construction and having brush holder and field coil supports. The bulletin enters into a detailed description of this motor and contains a speed table, characteristic curves and dimension diagrams.

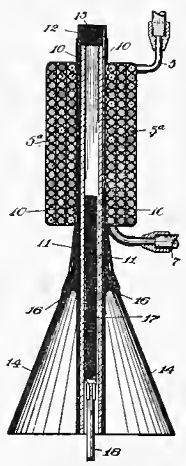
PATENTS

949,103. Commutator for Dynamo-Electric Machines. Miles Walker, Manchester, England, assignor to Westinghouse Electric & Manufacturing Company. A commutator cylinder comprising insulated commutator bars and having a series of



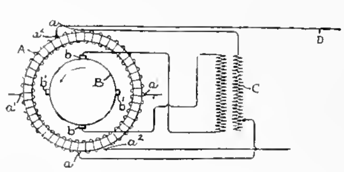
relatively deep peripheral grooves the side walls of which constitute plane contact surfaces, and clamping bands located in the bottoms of said grooves to hold the commutator bars against displacement.

949,184. Insulator for High-Potential Circuits. Joseph N. Kelman, Los Angeles, Cal. An insulator consisting of a plurality of spreading members and a tube, said spreading mem-



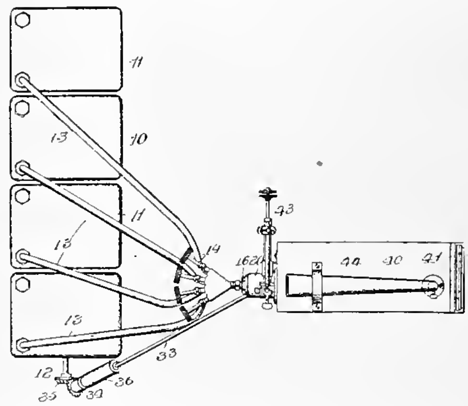
bers and said tube being constituted of laminae or layers of flexible fabric covered and impregnated with insulating varnish, said insulator having a rigid central insulating tube.

949,320. Variable-Frequency Generator. Giuseppe Faccioli, Schenectady, N. Y., assignor to General Electric Company. A variable-frequency, self-exciting alternating current generator having stator and rotor windings, one of said windings being provided with a commutator and brushes, a transformer having primary and secondary leads connected to



the rotor and stator windings respectively, means for varying the ratio of transformation of said transformer, and a load-circuit connected to points on the stator winding displaced from the points on said winding to which the transformer leads are connected.

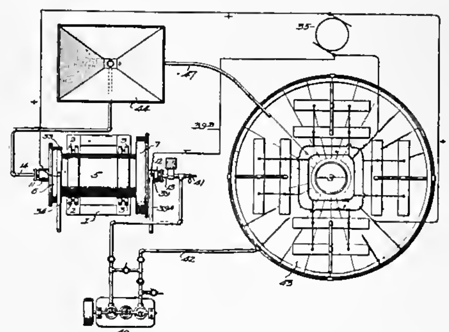
949,129. Engine Indicating Apparatus. Frederick Purdy, Kenosha, Wis., assignor of one-half to Foree Bain, La Grange, Ill. The combination with an engine, of an indicator comprising a receptive surface and an applicator for directing a tracing medium upon said receptive surface, one rotatable relative to the other about the center of indication, the rotative



part having connection with the engine for rotation in consonance with the cycles of operation of the engine, and said applicator being movable to radially deflect the tracing medium upon the receptive surface to vary its distance from the center of indication, and means responsive to pressure within the engine for so moving the applicator.

949,506. Art of Rejuvenating Storage Batteries. Alfred O. Tate, Toronto, Ontario, Canada. The method or process of rejuvenating or renewing a depleted storage battery cell of the applied oxid type which consists in electrolytically reducing the oxidized anodes and their applied oxid to metallic lead and simultaneously electrolytically oxidizing the spongy applied metallic lead of the cathodes until said anodes and cathodes shall have assumed their normal or original efficiency.

949,016. Electrolytic Apparatus for Recovering Metals from Solutions. Wilbur A. Hendryx, Denver, Colo. In an electrolytic depositing apparatus, the combination with a tank provided with a supply of a chemical ore pulp solution, a pump connected to said tank, a revolving electrolytic depos-



iting device connected to said pump, having an anode comprised of a suitable metal in a granulated or shot form, and a cathode comprised of a suitable metal in a granulated or shot form, and means including a pipe for conveying the solution from said filtering device to said tank, as specified.

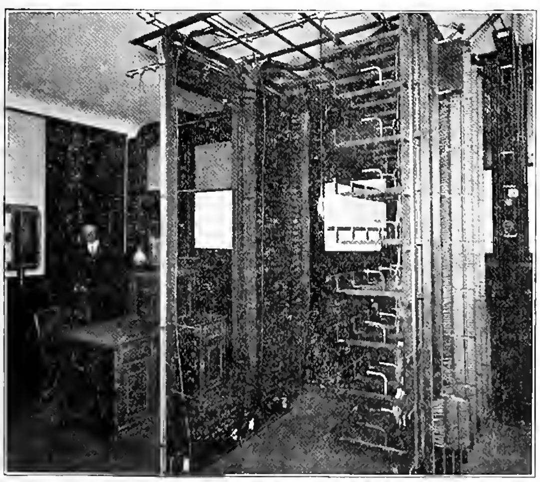
INDUSTRIAL

KELLOGG TELEPHONES IN ARIZONA.

Three flourishing little cities in Arizona—Prescott, Globe and Bisbee—have recently installed common battery multiple switchboards. These are the 4-party harmonic multiple type, and the only up-to-date common battery multiple plants in the territory. In fact, the territory has only one other common battery plant. Although thinly populated, the towns and cities of that section are making a remarkable growth, and the citizens are wide awake and demand the best.

Front View, Prescott Switchboard.

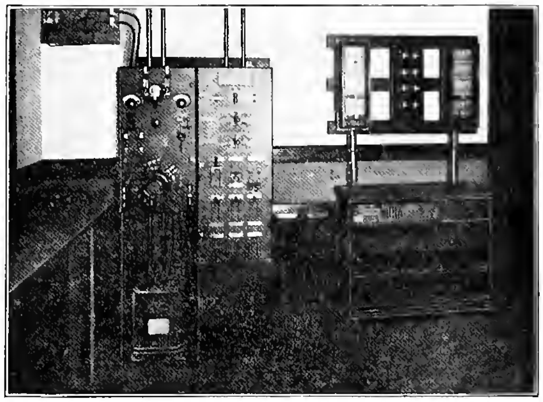
All three plants were equipped and installed by the Kellogg Switchboard & Supply Co. In the illustrations the Prescott equipment is shown. This board is in two multiple sections, each section being six-panel, two position, with a capacity of 3000 multiple jacks. Golden oak is the material used throughout in the cabinet work. The board is equipped with 520 C. B. lamp signal line circuits and 20 rural and toll lines. Three operators handle the city lines, while a fourth has the rural and toll lines.



Distributing Frame and Wire-Chief's Desk.

Fifteen standard Kellogg, double supervisory cord circuits comprises the equipment for each regular subscriber's operator, and ready means of testing cord and line circuits are provided. The standard Kellogg breast plate transmitter and head receiver is used by each operator. A matter deserving special attention is the manner of lighting. Each section is lighted by electric lamps placed in trough reflectors. The wiring for these lamps is run in iron conduits throughout the board and reduces fire risks to a minimum.

The standard wire-chief's desk is built in convenient form for testing work. The equipment is placed so that top of the desk is free for writing or other work, and is free from cords and plugs, all circuits terminating in keys.



Power Switchboard and Pole Changers.

The power plant is most complete, being furnished with duplicate sets of storage batteries and duplicate ringing equipment. Two sets of four frequency vibrating pole changer and transformer sets make up the ringing equipment. This equipment is universally used in Kellogg four-party plants with the greatest satisfaction. The storage batteries are charged by means of a mercury arc rectifier, accepted generally by telephone engineers as the most economical and efficient method of charging storage batteries from alternating current.

ELEVATOR CONTROLLERS.

The Cutler-Hammer Mfg. Co. of Milwaukee, has recently redesigned its entire line of electric elevator controllers. As now constituted the line embraces three types of full magnet controllers for direct current elevators and two full magnet controllers for alternating current, the various types providing suitable contol for high speed and moderate speed passenger elevators and a simplified form of full magnet control for freight elevators.

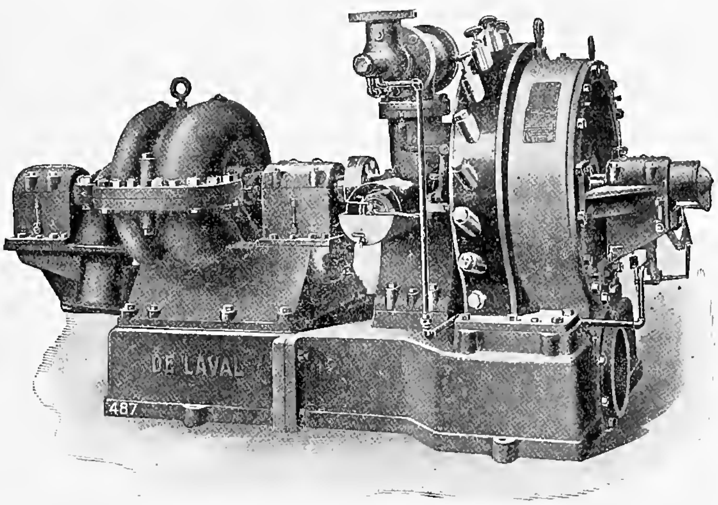
Eight different types of direct current, semi-magnet controllers are provided and four semi-magnet controllers for alternating current. The line includes, also, mechanically operated controllers suitable for use where the voltage of the line is extremely variable, reversing and non-reversing controllers for belt driven freight elevators, and a compact drum type controller for use with sidewalk lifts.

The Cutler-Hammer line of alternating current controllers is particularly interesting as indicating the increasing use of the induction motor in elevator service. Up to within a comparatively short time ago direct current motors were almost invariably used for this class of work, but recent developments in the controller art have made it possible to employ the full magnet system of control with alternating current motors also. It is stated that the polyphase brake solenoids used with alternating current motors operating elevators are now practically noiseless, thus eliminating the annoying humming which was formerly a serious objection to the use of alternating current controllers, particularly when installed in residences, office buildings or hospitals.

STEAM TURBINE-DRIVEN CENTRIFUGAL BOILER FEED PUMPS.

The first requisite of a boiler feed pump is the ability to give uninterrupted service while receiving little, and often unskilled, attention. For this reason the simple direct-acting pump has long held the field, in spite of its many shortcomings such as an enormous steam consumption, tendency to produce shock and vibration, unsuitability for close regulation, numerous valves, etc.

The centrifugal boiler feeder, which has lately been taken up by several of the largest steam power plants in the United States, is free of these defects and possesses several important advantages in addition. It does not endanger the pipe line by vibration, by excessive pressure, nor by shock. The inflow of water can be regulated at the boiler without reference to the pump. A centrifugal boiler feed pump contains no valves and only two packings, of quite small diameter, to be kept tight against hot water. There is no danger of breakage of pistons, cylinder heads or packing rings through loss of suction and consequent pounding. The adherents of the direct acting pump have asserted that with



Turbine Driven Centrifugal Boiler Feed Pump.

the pump in motion the operator can always be sure that water is going into the boiler, but this supposed advantage does not obtain where one or more pumps are feeding several boilers and, moreover, it is quite possible for a piston pump with one valve displaced to run steadily without forcing water into the boiler.

One thing that has retarded the introduction of the centrifugal boiler feed pump is the fact that it is not suited to reciprocating engine drive, as the comparatively low speed of the latter makes necessary a large number of stages in order to obtain the high heads required to overcome modern boiler pressure and if an attempt is made to keep down the number of stages by making the impeller large in diameter, the efficiency is seriously reduced. However, if the pump is to be driven by a steam turbine or electric motor this becomes an advantage. For instance, the impellers of the two-stage steam turbine driven pump shown by the accompanying photograph, designed to deliver 1600 gallons per minute against a head of 700 feet at 2800 revolutions per minute, are quite moderate in diameter.

Simplicity of construction and accessibility for inspection are essentials for any pump that is to be installed in a boiler room and entrusted to unskilled labor. It should be possible to get at the working and wearing parts of a pump without disturbing pipe connections. As will be noted from the accompanying photograph the casing of this pump consists of two parts only, the bottom casting and the cover casting. In the bottom casting are formed the inlet and outlet passages to the piping, while both castings contain passages leading from the delivery of the first impeller to the inlet of the second, these passages being cast in the solid metal. Smoothness and exact form of the passages are secured by the use of dry sand moulds exclusively. The top or cover casting, when raised, exposes the shaft and the impeller, that is the entire interior and all working parts of the pump, and after removing the shaft bearing caps, the impeller may be lifted out entire, so that all parts are rendered accessible by the breaking of only one packed joint, namely, that between the two halves of the main casting. The connections to the suction and discharge pipes need not be disturbed in any way. The flange of the suction opening may be seen at the end of the pump under the bearing, while the discharge opening is directed horizontally on the further side of the pump.

The bearings of a boiler feed pump destined to be operated for long periods without attention should be the best obtainable. In the present case they are all of the ring-oiled type used for electric motors and generators. They are of very ample dimensions and are supported on hollow brackets of pedestals entirely separate from the pump casting. These pedestals contain oil wells and are fitted with the usual cocks and gauge glasses.

The pump is directly driven through a flexible coupling by a steam turbine upon the same bed plate. The turbine is designed to receive steam at 200 lbs. gauge pressure with 150 deg. F. superheat and to exhaust into open heaters. The power for operating the pump therefore costs practically nothing, as all of the energy of the steam is returned to the boiler in the feed water, including even that expended as work and friction in the pump and turbine.

The governor of the turbine is an interesting feature. The pump can be controlled by an ordinary pump governor, of either the constant or excess pressure type, inserted in the steam line ahead of the turbine, the turbine governor acting merely as a maximum speed limit. The turbine governor is driven by a worm gear from the shaft at a speed of 900 revolutions per minute, making possible the use of a heavy, powerful construction. As an additional guarantee against excessive speed, an emergency governor is fitted to the end of the shaft. In case of overspeeding this governor trips a lever, which relieves steam pressure from under a piston controlling the emergency valve in the steam pipe outside of the turbine. The pipes connecting the emergency governor and the emergency valve may be seen in the picture. Even in the case of failure of both governors the turbine could suffer only minor damage, as the wheel is so designed that long before its limit of strength is reached, the buckets will fly off, upon which the disc will come to rest. The single solid disc of this turbine is comparatively easy to balance, although it is quite difficult to balance a shaft with several discs threaded on it.

In a turbine of this type the best steam economy is secured when the nozzles are receiving steam at the full pressure: In order to make possible the running of the nozzles at the highest efficiency at all times, including periods of light load, it is only necessary to supply hand or automatically operated valves for shutting off one or more nozzles as may be required. Such valves may be observed at the top of the machine in the photograph.

The machine here described and illustrated is one of two shipped to the Detroit Edison Company by the De Laval Steam Turbine Co., of Trenton, N. J. The pump has shown under test at full load an efficiency of over 60%, which considering the capacity is unusualy high. Larger pumps of this type and make have shown efficiencies above 85%.

FIELD RHEOSTATS DESIGNED FOR REMOTE CONTROL.

One of the troublesome problems in the design of switchboards has been that of finding a place for the large generator field rheostat. The General Electric Company have solved this problem by designing a rheostat, the type CR 179, which admits of remote control, the controlling switch only being located on the switchboard, while the rheostat itself is installed at any point where convenience and economy of space may dictate.

The details of its construction and the manner of operating it are clearly shown in Figs. 1 and 2. The rheostat

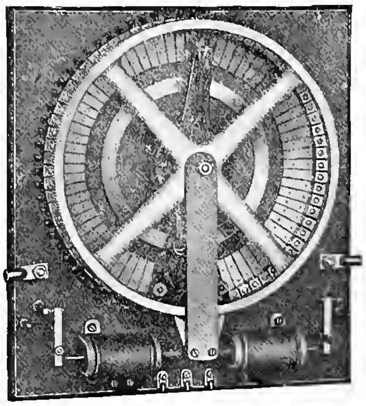


Fig. 1. CR 179-100 ampere ratchet driven field rheostat switch.

arm is rigidly fastened to a wheel with a toothed rim. Pawls fastened to the common core of the two magnets (AA), Fig. 2, engage the toothed rim of the wheel mentioned above and move it clock-wise or counter clock-wise.

To cut resistance into the field, close the double pole switch B to the left, energizing the left hand solenoid and causing the left hand pawl to engage the rim of the wheel, moving it in a clock-wise direction. When the solenoid core has reached its extreme point of travel, the solenoid circuit is automatically opened by the small switch C, allowing the pawl to be returned to the position midway between the solenoids by a spring, and permitting the switch C to again close,

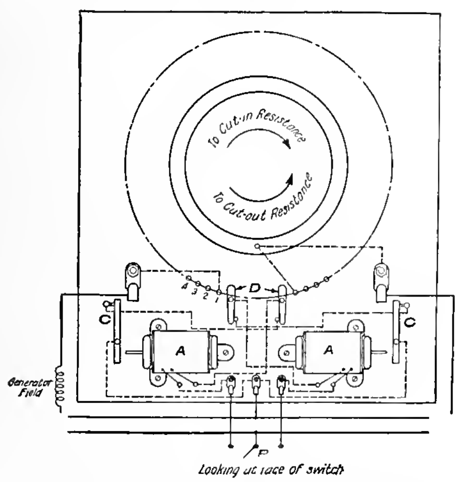


Fig. 2. Connections of CR 179 solenoid operated ratchet driven field rheostat switch.

starting anew the cycle of operations just described. This cycle of operation is repeated over and over again until switch B is opened. To cut-out resistance switch B is closed to the right, causing the same cycle of operations as described above, with the exception that the right hand solenoid is energized and the arm is driven counter clock-wise.

Each end of the switch dial is provided with a limit switch D which is automatically operated by the switch arm to open the circuit of the solenoid when the resistance is entirely cut in or out, protecting the apparatus in case the solenoid is left energized when the arm has reached its extreme point of travel. There are no high speed revolving parts which, due to their inertia, continue to cut in resistance after the controlling circuit has been opened. As compared with motor operated rheostats, this device possesses the following advantages: Costs less, admits of closer regulation of resistance, requires no attention, requires less space, is lighter in weight, and can be made self-contained. Repairs are much simpler and can be more quickly made, and the cost of maintenance is less.

NEW CATALOGUES.

Bulletin 89 from Wagner Electric Mfg. Co. gives full details regarding the Wagner type B. W. polyphase induction motor.

Bulletin No. 4689, recently issued by the General Electric Company, is devoted to the subject of Ornamental Street Lighting.

Bulletin No. 6 from the Kelman Electric & Mfg. Co., of Los Angeles, Cal., illustrates and describes High Voltage Disconnecting Switches.

Trumbull Cheer for February from the Trumbull Electric Manufacturing Company, contains the announcement of winners in the recent Lincoln penny contest.

Railway Signal Volt-Ammeter, Type S for testing direct current railway signal apparatus and similar work on telephone and telegraph circuits is described in Bulletin No. 4714 from the General Electric Company.

The Illuminating Engineering Laboratories, Welsbach Company, Gloucester, N. J., have published valuable rules suggestions and information on Welsbach Illumination in their "Gas Solicitors' Handbook," compiled by Norman Macbeth.

Worthington Turbine Pumps for high and low head service are illustrated and described in construction and operation in two interesting booklets from Henry R. Worthington, 115 Broadway, New York City. W-175 is devoted to high head turbine pumps and W-176 to centrifugal pumps for low head service.

The General Electric Company has issued a small pamphlet, No. 3907, descriptive of the G. E. Mazda lamp. This lamp is the most recent and improved development in high efficiency metal filament lamps. It represents the result of the combined research work and manufacturing experience of the laboratories and factories of the most important lamp manufacturers and inventors in the world, secured through the acquisition of the most improved processes.

In a 128 page booklet just issued by the Cutler-Hammer Mfg. Co., of Milwaukee, the subject of the control of electrically operated elevators is fully covered. The first section of the booklet contains illustrated descriptions of full magnet and semi-magnet direct current controllers for high speed, moderate speed and slow speed passenger and freight elevators, together with descriptions of sidewalk lift controllers, reversible and non-reversible controllers for belt driven freight elevators and mechanically operated controllers for use where current conditions are extremely variable. Illustrations and descriptions are also given of such necessary elevator accessories as brake magnets, car switches, limit switches, etc. The second section of the booklet is devoted to similar controllers for use on alternating current circuits and the concluding pages contain tables of useful information, including suggestions regarding the proper type of motor to use in each case.

APPROVED ELECTRICAL DEVICES

RECEPTACLES, STANDARD.

"Bryant." Key and Pull (50 C. P. 250 V.) and Keyless (3 A. 250 V.) Wall Sockets, Brass Shell (slotted or closed bases). Key, Cat. Nos. 9184, 60018, "New Wrinkle" 66609, 68136, 68139, Angle Base 50753, and "New Wrinkle" 68224. Keyless, Cat. Nos. 9185, 50717, 60019, 60020, "New Wrinkle" 66610, 68137, 68140, Angle Base 50755 and "New Wrinkle" 68225. Pull, "New Wrinkle" Cat. Nos. 66611, 68128, 68138 and Angle Base 68236. Also all of the above types with shadeholders attached; key types with composition or insulated metal key. Brass sub-bases, Cat. Nos. 374 and 377, for use with Cat. Nos. 68139 and 68140. Approved Feb. 6. 1910. Manufactured by

The Bryant Electric Company, Bridgeport, Conn.

"Bryant 3 A. 250 V." Sign, Cat. Nos. 1700, 40488, 46749, 59108. Cleat, Cat. Nos. 9402, 4903, 921, 1011, 1123, 50715, 11221, 28795, 58949 (formerly 23209), 58300, and 58301 (formerly 23-210). Concealed, Cat. Nos. 50744; also 9447, fusible, 2 A., 125 V. Moulding Cat. Nos. 42453, 58302 and 58950 (formerly 34152). Conduit Box, Cat. Nos. 9514, 9397, 40507, 40537, 59107, 62357, 62355 and 62356. Approved Feb. 4, 1910. Manufactured by

The Bryant Electric Company, Bridgeport, Conn.

Rosette Receptacles mounted on link fuse rosette bases, 2 A., 125 V. Brass Shell. Cleat Type, Cat. Nos. 50730, 50733, "New Wrinkle" 68227, 68232, 68238. Concealed Type, Cat. Nos. 50729, 50732, "New Wrinkle" 68226, 68231, 68237. Porcelain: Cleat Type, Cat. Nos. 9434, 9436, 9438. Concealed Type, 9404, 9405, 9406. Also all of the above aypes with shadeholders attached; key types with composition or insulated metal keys. Approved Feb. 5, 1910. Manufactured by

The Bryant Electric Co., Bridgeport, Conn.

"Perkins" Key and Keyless, (2 A., 125 V.) Rosette Receptacles, monnted on link fuse rosette bases. Brass Shell. Cleat, Cat. Nos. 24991, 24994, "New Wrinkle" 68227-P and 68232-P. Concealed, Cat. Nos. 24990, 24993, "New Wrinkle" 68226-P and 68231-P. Porcelain. Cleat, Cat. Nos. 25091, 25092. Concealed, Cat. Nos. 25093, 25094. Also all of the above types with shadeholders attached; key types with composition or insulated metal keys. Approved Feb. 3, 1910. Manufactured by

The Perkins Electric Switch Mfg. Co., Bridgeport, Conn.

"Perkins," Key (50 C. P., 250 V.) and Keyless (3 A., 250 V.) Wall Sockets, brass shell. Slotted or closed bases. Key, Cat. Nos. 9184-P "New Wrinkle" 66609-P, 68136-P, 68139-P, and angle base 68224-P. Keyless, Cat. Nos. 9185-P, "New Wrinkle" 66610-P, 68137-P, 68140-P and angle base 68225-P. Also all of the above types with shadeholders attached; key types with composition or insnlated metal keys. Brass snb-bases, Cat. Nos. 374 and 377 for use with Cat. Nos. 68139-P and 68140-P. Approved Feb. 6, 1910. Manufactured by

The Perkins Electric Switch Mfg. Co., Bridgeport, Conn.

Wall Sockets, Brass Shell. Key Cat. Nos. 2100 and angle base 2700. Keyless Cat. Nos. 2300 and angle base 2800. Cleat Type Cat. No. 3100. Approved Jan. 29, 1910. Manufactured by

Wirt Mfg. Co., Burrage, Mass.

SOCKETS, STANDARD.

Porcelain Shell Sockett, Cat. No. 61417 (417). Approved for temporary outdoor use and only when connected to stranded rubber covered wires; Jan. 28, 1910. Manufactured by

Pass & Seymour, Inc., Solvay, N. Y.

Wall Sockets. Brass Shell. Key, Cat. Nos. 60430, 61066, 61067, 61069, 61387 (387), 61455 (455), 62350 and 103075. Keyless, Cat. Nos. 60387 (0387), 60431, 61456 (456) and 62351. Porcelain Shell. Key, Cat. Nos. 61087 (1087), 61237 (237) 62247 (247) and 62371 (2371). Keyless, Cat. Nos. 60237 (0237), 60247 (0247), 60371 (02371), and 61107 (107). Approved Jan. 13, 1910. Manufactnred by

Pass & Seymour, Inc., Solvay, N. Y.

CONDUIT BOXES.

Pressed Steel Boxes, Cat. Nos. A. 1-½, B ½, ¾, 1-½ and 2-⅛; C ¾ and 1-½; D 1-½ and 2-⅛; E 1-⅞ with suitable covers of pressed steel. Approved Jan. 28, 1910. Manufactured by

Steel City Electric Co., No. 1207 Washington ave., Pittsburg, Pa.

CONDUIT BOXES, FLOOR OUTLET.

"T. & B." Cast Iron Floor Outlet Boxes, with Hubbell receptacle 10 A., 250 V., Cat. No. 100 and "Watertight" No. 1100. Approved Jan 24, 1910. Manufactured by

Thomas & Betts Co., No. 299 Broadway, New York, N. Y.

LAMP ADJUSTERS.

This adjuster consists of a metal telescoping arm with a head for securing the device to a ceiling. Mounted in the head is a spring actuated drum on which is wound a cord. This cord is attached to the flexible conductor supplying the lamp. The device should be so installed that the arm will be used in a nearly vertical position. Vertical adjustment of lamp to be then secured by action of the drum. Approved for use only with approved reinforced portable cord; Jan. 28. 1910. Manufactured by

Frantz Specialty Mfg. Co., Sterling, Ill.

ROSETTES, FUSELESS.

"Circle T," 3 A., 250 V. Cleat, Cat. Nos. 750 and 752. Concealed Cat. No. 753. Moulding, Cat. No. 754. Approved Jan. 31, 1910 Manufactnred by

Trumbull Electric Mfg Co., Plainville, Conn.

SWITCHES, OIL BREAK.

Non-automatic Oil Switches for A. C. circuits, 3300 and 6600 volts. Type D, 100-1000 amperes not over 3300 volts, 100, 200 and 300 amperes not over 6600 volts. Type I, 50 amperes, 3300 and 6600 volts. Approved Jan. 28, 1910. Manufactured by

Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

RECEPTACLES, FOR ATTACHMENT PLUGS.

"Bryant" Flush Receptacle, Edison type. Cat. No. 1708, 3 A. 250 V., 6 A. 125 V., for use with Edison type attachment plug. Approved Jan. 11, 1910. Mannfactured by

The Bryant Electric Co., Bridgeport, Mass.

RECEPTACLES, MINIATURE.

"P. & S." ½ A., 125 V. Candelabra Sign Receptacles, Cat. Nos. 677, 778 and 878. Approved Jan. 13, 1910. Manufactured by

Pass & Seymour, Inc., Solvay, N. Y.

SOCKETS, WEATHERPROOF.

"Freeman," 3 A., 250 V. Two-piece porcelain sockets enclosed in two-piece aluminum or brass shells. Cat. Nos. 182-185 incl. For use with 110 or 220 V. lamps in series on 600 V. circuits. Approved Feb. 2, 1910. Manufactured by

E. H. Freeman Electric Co., Trenton, N. J.

CIRCUIT BREAKERS.

"S. E." Single pole air brake types, 15-1200 Amps., not over 600 volts. Approved Jan. 29, 1910. Mannfactured by

Roller-Smith Company, 203 Broadway, New York, N. Y.

NEWS NOTES

FINANCIAL.

SEATTLE, WASH.—The bids of R. H. Rollins & Sons and A. B. Leach & Company for park bonds in sum of $500,000 and the light bonds for sum of $200,000 have been accepted by the Council.

SAN FRANCISCO, CAL.—The Northern California Power Company has increased the monthly dividend from 10c to 20c per share. Books were closed February 16th and the dividend, which was payable on the 22d, was paid on the 21st, owing to the holiday.

LOS ANGELES, CAL.—At the annual meeting of the stockholders of the Pacific Lighting Corporation the officers were re-elected, as follows: C. O. G. Miller, president; George H. Collins, vice-president; Horace H. Miller, secretary. The annual reports show gross sales, $2,892,000, an increase of $346,000 over the year 1908, or 13.6 per cent. After deducting operating expenses, interest, taxes and depreciation there remained a net profit of $642,232.35, out of which was paid the regular 5 per cent dividend on the preferred stock amounting to $208,100, and a quarterly dividend on the common stock of 75c per share was paid in November amounting to $36,000, the total dividends being $244,100. The company reported no interest-bearing floating debt. The Pacific Lighting Corporation was organized May 20, 1907, succeeding the Pacific Lighting Company. It owns all the stock of the Los Angeles Gas and Electric Company and practically all of that of the Pasadena Consolidated Gas Company, as well as $220,000 bonds of the Eureka Lighting Company and other assets.

INCORPORATIONS.

BOISE, IDAHO.—The Orchard Water Company of Boise, with a capital stock of $20,000, has been incorporated by J. H. Richards, T. S. Risser and E. L. Hice.

YAMHILL, ORE.—Yamhill Mutual Telephone Company, with a capital stock of $2,500, has been incorporated by W. G. Moore, E. B. Flett and A. C. Goodrich.

SPOKANE, WASH.—The Spokane American Oil and Gas Company, with a capital stock of $1,000,000, has been incorporated by J. F. Ferguson, D. P. Reid, J. M. Ralph and P. Anderson.

PORTLAND, ORE.—Sterling Oil and Gas Company; principal office, Portland, Ore., with a capital stock of $75,000, has been incorporated by W. H. Moorehouse, W. W. Zellers and Russell E. Soewall.

VISALIA, CAL.—The Lindsay Water Company, with a capital stock of $75,000, has been incorporated by C. O. Cowles, W. C. Stelling, G. K. Hostetter, G. F. and F. F. Hostetter and Carrie L. Flagg.

TRANSMISSION.

VANCOUVER, B. C.—The Vancouver Power Company is preparing to install a 20,000 horsepower unit at the Lake Buntzen plant that will cost $500,000.

LYONSVILLE, CAL.—The Butte and Tehama Power Company has started work on its proposed power plant on Mill Creek, 14 miles south of Lyonsville.

SEATTLE, WASH.—Plans for the expenditure of over $2,500,000 in the construction of a hydroelectric power plant at Lake Tapps, Pierce County, and the development and distribution among the Sound cities of 25,000 electric horsepower, all within the next two years, have been approved by Stone & Webster of Boston, backers of the Pacific Coast Power Company and managers of the Seattle Electric Company. News was given out by Henry G. Bradlee, member of Stone & Webster.

PORT ANGELES, WASH.—The city has granted the Port Angeles Power Electric Company a franchise for the distribution, sale, etc., of electrical power. The company proposes to begin the construction of a 500 horsepower plant on Little River.

ROCKPORT, WASH.—The Skagit County Power Company is planning to begin actual construction work this spring on its power plant on the upper Skagit River, 30 miles from Rockport. The proposed power plant will cost in the neighborhood of $6,000,000. It will have a capacity of 100,000 horsepower. A flume 20,000 feet long and averaging about 20 feet in width is being built in order to obtain "head." The river at present is a succession of small cascades and will be harnessed and forced through a long tunnel, most of which is to be cut through solid rock. E. H. Freeman, Anacortes, Wash., is field manager. In connection with the work the Great Northern Railway, A. Stewart, assistant chief engineer, Seattle, Wash., is to build a 30-mile branch to the site of the power plant, to be used in carrying in supplies for the work. Surveys for the branch have been made and work is to be started shortly.

WASHINGTON, D. C.—A request has been received from the Edison Electric Company for four years' more time to carry out the conditions of its permits for further development on Kern River. It was originally allowed five years to do a certain amount of construction. Kern River being in Representative Smith's district, he was asked to introduce a bill giving the additional time. The request met with refusal on the ground that the company must live up to its agreements with the Government as others are required to do, and also because an expenditure of only $160,000 in four years on projects totaling eight or nine millions did not make it appear prima facie that the company had put forth much effort to carry out the conditions agreed to. If the company produces evidence of good faith the Forest Service will probably help it out, but Smith's stand prevents the establishment of legislative precedent.

ILLUMINATION.

EVERETT, WASH.—The Everett Gas Company will extend its mains in different sections of the city.

OLYMPIA, WASH.—Henry H. Hyde of Tacoma has purchased the Olympia Gas Company and announces that extensions and improvements will be made at once.

MEDFORD, ORE.—J. R. Anderson of Pasadena, who is connected with the company owning gas plants in California, is in Medford looking over the field and may request a franchise.

LOS ANGELES, CAL.—The Los Angeles Gas & Electric Company will commence in a few days laying gas mains to Ingomar tract which is located on Prospect avenue, west of the Hollywood hotel.

MEDFORD, ORE.—Elmer C. Johnson, of Portland, has asked a franchise for a gas plant in Medford, for a period of 40 years. If the franchise is granted Mr. Johnson will expend $12,500 within 12 months for material.

CENTRALIA, WASH.—N. W. Mills of Tacoma has secured the contract to build a concrete gas tank for the Centralia and Chehalis Gas Company, estimated cost will be between $12,000 and $15,000, work to be commenced at once and completed May 1st. It will be located on Coal creek near Chehalis.

CITY OF MEXICO, MEX.—The estimate of loss by a fire in the shops of the Mexican Central division of the National Railways of Mexico in this city recently is from $25,000 to $30,000. Officials of that company state that the gas plant was only partly destroyed and will within a few days, be in operation to about one-half its regular capacity.

GRANGEVILLE, IDAHO.—W. A. Clark of Moscow, who conducts the gas plant in this city, has asked for a twenty-five year franchise in Grangeville for the purpose of laying gas mains in the streets and also to convey gas to various sections of the city for the purpose of lighting and heating, and it is said the Council looks with considerable favor upon the granting of such a franchise.

TRANSPORTATION.

VACAVILLE, CAL.—The Vallejo and Northern Railroad Company has applied for a 50-year franchise through this city.

BIGFORK, MONT.—Civil Engineer P. E. March has begun the survey for the proposed electric line to be built by the Whitefish & Polson Electric Railway Company.

SAN JOSE, CAL.—F. E. Chapin, vice-president and general manager of the Peninsula Railway Company, announces that the line between Palo Alto and San Jose has been completed and electrized and that it will be ready for operation about March 1st.

SAN FRANCISCO, CAL.—At the annual meeting of the stockholders of the Petaluma and Santa Rosa Railroad Company the board of directors was re-elected, to wit: E. M. Van Frank, president; Thomas Archer, secretary; A. W. Ballard, John A. McNear, Francis Cutting, Frank A. Brush and Rudolph Spreckels. Edwin T. McMurray is the attorney. The report made by the president showed about $15,000 increase in receipts over and above operating expenses as compared with the previous year. No dividends have yet been paid, but this electric line is handling a large passenger and freight traffic. At the directors' meeting two propositions were discussed, one being the extension of the line from Graton to Camp Meeker, and the Russian River; the other an extension to Occidental.

FRESNO, CAL.—Work on the long fill between Fowler and Selma on the right of way of the Fresno-Hanford interurban railroad, which has been in progress for the past two weeks, is finished, George W. Elder has announced. With the completion of this work the grading camp will be moved to a point just this side of Selma, where another fill will be made. In filling up the first arroyo, 12,000 yards of earth were required. The work is practically completed, however, and the fill is up to the grade. A representative of the General Electric Company of Schenectady, N. Y., is in Fresno conferring with Granger and George A. Yuille regarding supplies for the new power plant at Fowler and the car motors. The General Electric Company agrees to have everything on the ground in this city within four months. The Hudson Counties Improvement Company will close the contract.

SACRAMENTO, CAL.—A. D. Miller, manager of the Nevada Transit Company of Reno, who has been employed by that company since it became the property of the Hammon interests, will become manager of the Central California Traction Company, with headquarters at Stockton. The Central California Traction Company has a line operating between Lodi and Stockton and is building another between Sacramento and Stockton. It is planned by the company to have the Sacramento-Stockton line in operation by the first or middle of July. At present no work is being done on the Sacramento end of the line, an injunction suit preventing work near the State Agricultural Park and work on Eighth street, this city, being suspended pending the adjustment of an agreement pertaining to paying the property owners for a portion of the street.

WATERWORKS.

EL CENTRO, CAL.—$69,000 bonds will be issued for the acquirement of a municipal water system for El Centro.

PATTERSON, EMERALD STATION, CAL.—An entire waterworks system is to be installed here by the J. A. Ulmer Machinery Company.

CRESSWELL, ORE.—The City Council granted to R. H. Parsons of this city, a franchise to furnish the city with water for a period of 25 years.

TAFT, CAL.—Harry D. Chapman, a contracting engineer of Ocean Park, has asked for a franchise for the installation of a water system in the town of Taft.

HOLTVILLE, CAL.—The City Council passed an ordinance in regard to the issuance and sale of bonds to the amount of $37,000 for the acquisition, construction and completion of a waterworks.

PORTLAND, ORE.—Sealed proposals have been received by Auditor A. L. Barbour for the construction of a water main in Division street from the west line of East Tenth street, to a six-inch main in East Eleventh street.

CORONA, CAL.—Seven or eight miles of roads are being graded and three miles of pipe are being laid, four or five additional wells are to be put down and a 150 horsepower pump plant will be installed by the Citrus Belt Lane Co.

TACOMA, WASH.—The City Council has passed an ordinance providing for the construction of water mains on South Seventh street from Lawrence street to Proctor street; on South Eighth street, from Lawrence street to Proctor street and on South Ninth street, Tenth and Eleventh street, each from Lawrence to Proctor streets.

ESCONDIDO, CAL.—Officials of East San Pasqual Water Company and West San Pasqual Water Company, are perfecting plans for the merging of the two companies. The new company will extend a system two miles up the San Pasqual river valley. Here tanks will be erected and arrangements made to store water to provide irrigation during the dry season.

SUSANVILLE, CAL.—Notices of the appropriation of the waters of Eagle Lake and Willow Creek have been filed with County Recorder Sharp. The appropriations call for 200,000 inches of the waters of Eagle Lake and the streams flowing into the lake, the 200,000 inches of the waters of Willow creek. The locations are made by Alva Udell, an attorney of San Francisco. The waters of Eagle Lake are claimed by a prior location made by the Lassen-Willow Creek Water Company, formed about four years ago for the purpose of tapping the lake by a tunnel over a mile in length.

SACRAMENTO, CAL.—The East Sacramento Water Company has applied to the County Board of Supervisors for permission to lay pipes, etc., in East Sacramento, Elmhurst, Brighton and all other principal suburbs. The site for the tower and works was decided upon. The plant will be housed in a structure of reinforced concrete, with steel floors and bracings. The tower will have a capacity of 150,000 gallons and the floor of the tank will be 100 feet above ground, thus insuring a good force. About 800,000 feet of pipe will be laid and will extend to Elmhurst, the district about Florin, to East Sacramento, and eventually to Brighton and other outlying communities.

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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JOURNAL OF ELECTRICITY
POWER AND GAS

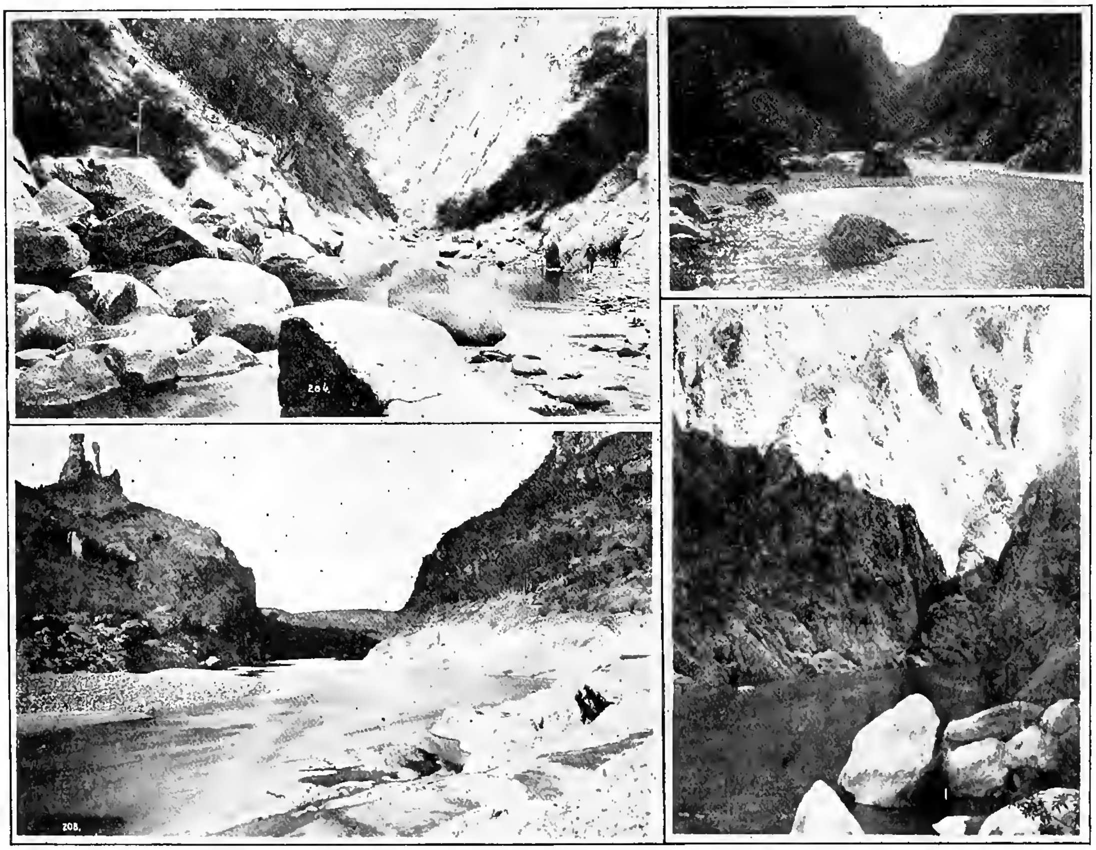
Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXIV | SAN FRANCISCO, MARCH 5, 1910. | NUMBER 10

POWER POSSIBILITIES OF THE MAYO RIVER, MEXICO

BY R. M. JONES.

Careful examinations of the Mayo River in Northern Mexico made by the writer during 1908 and 1909 showed that it may be admirably adapted for power production. Perpetual power rights of this stream from its start at the confluence of the Moris and the Candamena at La Junta in Chihuahua throughout the 155 miles of its course to Navojoa in the foothills of Sonora, have been acquired from the Mexican government by the Mayo River Power & Land Company. The greatest part of the drainage area of the river lies in the high mountainous country in western Chihuahua and eastern Sonora. It carries an abundance of water to operate the proposed plants of the company to their full capacity, with the assistance of



La Junta Damsite.
Pilares Damsite.

Mayo Damsite.
San Luis Damsite.

the reservoir to be constructed in connection with each plant. As there are two rainy seasons in each year, both of which cause a flow sufficient to fill the reservoirs, the storage capacity required is only little more than half that required in climates having only one wet season, allowing for extra capacity to provide for a possible dry winter season.

Within the limits of the company's concession are four good dam-sites: one just below its source at La Junta; one at dam-site No. 1; another at a point 27½ miles below dam-site No. 1; and the last at Pilares, just above San Bernardo. This last dam-site is 40 miles above Navajoa, and about 35 miles over a smooth, level wagon road from Alamos, a town of about 15,000 people on a branch line of the Southern Pacific. These four dam-sites have an aggregate capacity of 40,000 h. p. net delivered. I have advised the company to build the first dam and power plant at Pilares, because of the ease and cheapness with which material for construction can be taken to that place, and because the entire capacity of this plant can be contracted for in advance by mining and industrial corporation of undoubted responsibility.

Three great trunk lines are now building through this region. The Southern Pacific or Harriman lines are already contructed and in operation lengthwise through the central portion of the States of Sonora and Sinaloa as far south as Mazatlan, and are expected to reach Guadalajara next year. Stillwell is building the Orient road across the southern portions of Chihuahua and Sonora. This road now crosses the Southern Pacific and the Fuerte River at San Blass, 83 miles south of the Mayo, and has established terminal and harbor facilities at Topolobampo on the Gulf. The Mexican-Northwestern Railway Company, a forty million dollar corporation backed by the Pearson syndicate, will build just north of Ocampo and will strike the Mayo river at a point just below San Bernardo, following this river down to Navojoa, forming junction with the Southern Pacific and possibly to the Gulf of California, where terminal and harbor facilities will be established to take care of the Central and South American trade.

There are four large American corporations that are now engaged in irrigating and colonizing vast tracts of land in the State of Sonora in the vicinity of the Mayo River. One of these concerns owns 100,000 acres, another 110,000, the Richardson Brothers and John Hays Hammond have 600,000 acres along the Yaqui river and between the Yaqui and Mayo rivers, and still another concern has purchased 1,000,000 acres upon which they have already established a town on the Gulf of California called Port Lobos. In the Sierra Madre mountains, tributary to the Mayo river, there are great mining camps whose mines have been worked for 200 years. These include Ocampo, Trinidad, the new gold camp of Sobia on the Mayo river, the new copper camp of Piedras Verdes, 25 miles from San Bernardo, which is being thoroughly tested in a most systematic manner with diamond drills by the Ray Consolidated Copper Mining Company, and a new copper camp about 50 miles from San Bernardo, whose surface showings are said to surpass even those of Piedras Verdes.

It is estimated that not more than two years will be required to complete the first dam and power plant, which will have a capacity of 10,000 h. p. The construction of the dams will render the Mayo river navigable in stages to a point beyond the coal deposits, and mines. This river will, after the three dams contemplated are constructed, furnish cheap water transportation for the ores of all the mining camps tributary to this stream. This advantage of transportation will follow from the construction of the dams without extra cost, just as by-products are obtained from manufacturing establishments.

The only construction involved in this first, the Pilares plant, consists in a steel faced and rock filled dam 320 ft. long at top, and 260 ft. across the bottom in a box canyon. It will be 151 ft. high with 600 ft. of spillway provided for independently and away from the dam; one large bleeder tunnel 1400 feet long bypassing the dam; one working tunnel lined for low pressure, valves, fittings and pipe connections in the tunnel; concrete and steel power house, containing four 2500 k. w. generators directly connected to water wheels having 1/3 overload capacity; transforming station and equipments; and line construction aggregating 120 miles—40 miles being the longest one contemplated at present.

The Pilares plant is located but 35 miles from Alamos, Sonora, which is at the terminus of a Southern Pacific branch line from Navojoa. There is an excellent wagon road between San Bernardo and Alamos, leaving but two miles additional to construct to Pilares dam. The total development will consist of dam, tunnel and power plant, all within the radius of 1200 feet.

Selenium is obtained principally in the anode muds or slimes of the electrolytic copper refineries. The American Smelters Securities plant at Baltimore, Md., the Perth Amboy and the Chrome, N. J., refineries all have made more or less selenium. The Baltimore and the Chrome refineries get their crude copper from many sources, but that handled at Perth Amboy comes almost exclusively from Butte, Mont. Great tonnages of copper are handled at each of the smelters and the selenium recovered represents only minute traces in the original ores. The anode slimes in the copper refineries contain a large percentage, in many cases 50 per cent or more, of gold and silver. The slimes are treated in very large cupellation furnaces, as large as the reverberatory furnaces which a comparatively few years ago were used for copper smelting. Selenium is collected in the flue dusts from this cupellation, and is recovered by processes which differ with the refinery and which are hardly to be considered as more than experimental.

Successful Poulsen tests have been conducted during the past month under the direction of C.F. Elwell of San Francisco between Sacramento and Stockton, in the central valley of California. These two cities are fifty miles apart, but telephonic communication without connecting wires has been successfully established. It is claimed that the articulation is much clearer than with the ordinary type of telephone and the sound intensity at the receiving end as great as at the sending.

THE WATT-HOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

(Continued.)

CHAPTER II.

THE MEASUREMENT OF POWER.

The power in a direct current circuit is equal to the product of the electro motiveforce and the current; in other words, if I represents the current in amperes, and E, the e.m.f. in volts, then the

$$\text{Watts, } W = EI, \text{ or the kilowatts} = \frac{EI}{1000}$$

The power flowing in a direct current circuit can therefore be determined by the use of a voltmeter and an ammeter, or by one instrument, an indicating wattmeter, which will indicate the product of the volts and amperes.

The power flowing in an alternating current circuit is dependent not only upon the e.m.f. and the current, but also upon the power factor of the circuit. This is evident as is illustrated by Fig. 5, which shows

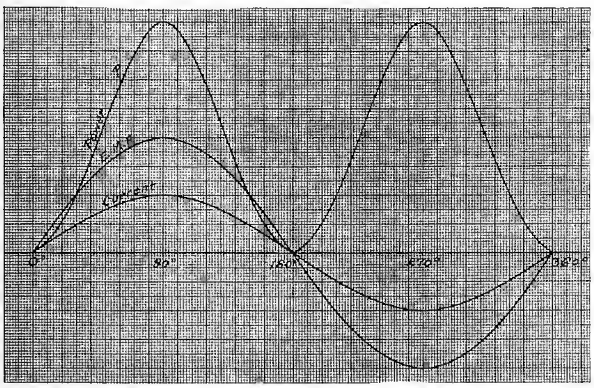


Fig. 5.

a sine wave of e.m.f and current at unity power factor. In Fig. 6 is shown the same current and e.m.f. but with a power factor of 50 per cent instead of unity. The instantaneous value of the power flowing in any

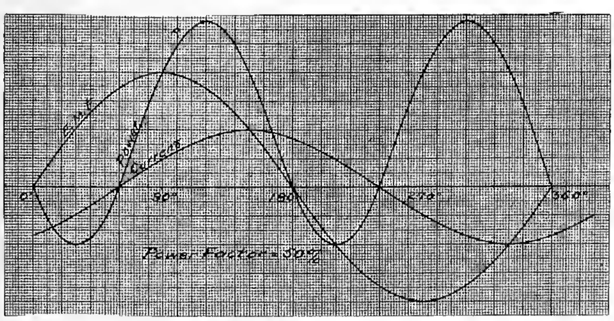


Fig 6.

circuit is equal to the product of the instantaneous value of the e.m.f, and the instantaneous values of the current.

The curve P represents these instantaneous values of the power. It will be noted that in the case of unity power factor (Fig. 5), the curve P is entirely above the axis, that is the line of zero value; this indicates that the power is all flowing in one direction. It will also be noted that the maximum value of the e. m. f. occurs at the same instant as the maximum current, which condition gives the maximum value of the power for these values of the current and the e.m.f., as can be seen from the figure.

Referring to Fig. 6, it will be noted that for a power factor of 50 per cent, part of the curve, P, is below the axis, which indicates that the power is not all flowing in the same direction, but that during a part of the cycle a portion of the power is actually being "pumped back" into the circuit. The net value of the power supplied is equal to the difference between that represented by the area enclosed by the curve, P, which is above the axis and the area enclosed by that part of the curve which is below the axis.

Assuming a sine wave of e. m. f., and of current (modern commercial alternating current generators give waves closely approximating a sine wave), and denoting the maximum value of the e.m.f. by **E**, the maximum value of the current by **I**, and the instantaneous value of the e.m.f. by e, we have

$$e = \mathbf{E} \sin \phi,$$

where $\phi = \omega t$, in which $\omega = 2\pi f$ (f being the frequency of the circuit in cycles per second) and t = the time in seconds measured from the instant when the e.m.f. crosses the axis in a positive or rising direction.

The instantaneous value of the current, $i = \mathbf{I} \sin (\phi - \theta)$, where θ = the angle of phase displacement between the current and the e. m. f. The instantaneous power, p, is equal to the product of the instantaneous e. m. f. and the instantaneous current, or

$$p = e\, i, = \mathbf{E} \sin \phi\ \mathbf{I} \sin (\phi - \theta)$$

$$\text{or } p = \mathbf{EI} \cos \theta \sin^2 \phi - \mathbf{EI} \sin \theta \sin \phi \cos \phi.$$

Let P = the average value of p,

$$\text{then } P = \text{av'g } \mathbf{EI} \cos \theta \sin^2 \phi - \mathbf{EI} \sin \theta \sin \phi \cos \phi).$$

$$= \mathbf{EI} \cos \theta \text{ (av'g } \sin^2 \phi) \ \mathbf{EI} \sin \text{ av'g } (\sin \phi \cos \phi).$$

The average value of $\sin \phi = \frac{1}{2}$, and the average value of $\sin \phi \cos \phi = O$, substituting these average values in the above equation, we have

$$P = \frac{\mathbf{EI} \cos \theta}{2}$$

But **E**, the maximum value of the e.m.f. wave $= \sqrt{2}\,E$, where E is the effective value of the e.m.f. Also, if I denotes the effective current, the maximum current, $\mathbf{I} = \sqrt{2}\, I$. Therefore, we have the fundamental formula:

$P = EI \cos \theta$; the $\cos \theta$ being the power factor of the circuit.

If the power factor is unity, then $\cos \theta = 1$, and hence the above equation becomes $P = EI$, which, as will be noted, is the same as for direct current. The power factor is very seldom as high as unity, and it is therefore almost always necessary to use a wattmeter rather than a voltmeter and ammeter; a properly constructed and accurately calibrated wattmeter will measure power correctly regardless of the value of the power factor. The power factor of a single phase alternating current can be easily obtained by taking the product of the volts and the amperes as indicated by a voltmeter and ammeter and dividing this result into the actual power reading as indicated by a wattmeter.

The actuating force in an indicating wattmeter is derived from two sets of coils, one being connected in multiple, and the other in series (as in the case of the watt-hour meter) with the load to be measured. The reaction between these two coils is at each instant proportional to the instantaneous values of the current and the e. m. f., so that the total deflecting force acting on the pointer of the instrument is at all times proportional to the true power.

A two-phase system (often called "quarter phase"), can be considered as two single phase systems, and the power being supplied by such a system is simply the sum of the power flowing in the two equivalent single-phase systems, and can be measured by a single-phase wattmeter in each system, or by one polyphase wattmeter as shown in Fig. 7, in which

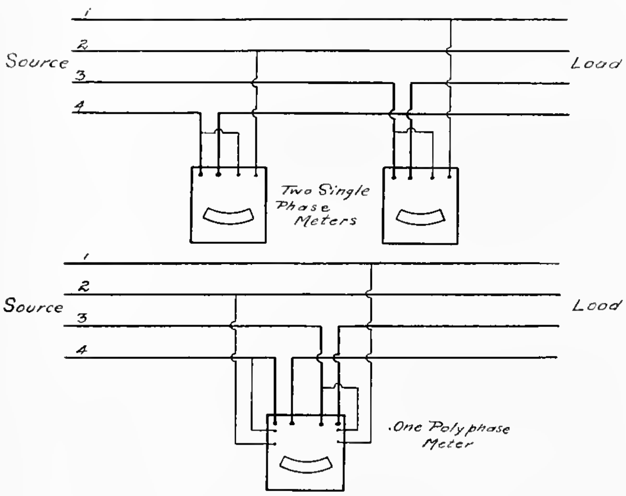


Fig. 7.

lines 1 and 3 constitute one-phase and 2 and 4 the other phase.

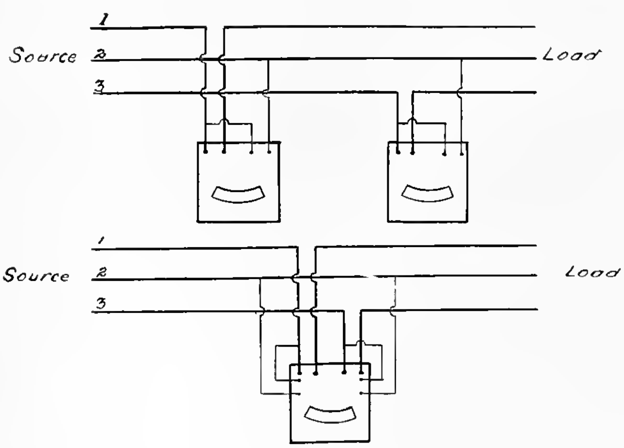


Fig. 8.

The power in a two-phase three-wire system can also be measured by two single-phase wattmeters or by one polyphase wattmeter, the connections being made as shown in Fig. 8, in which line number 2 carries the resultant current. Fig. 9 shows the connections used when measuring power in a balanced two-phase three-wire system with one single-phase meter. In this case the voltage impressed on the meter will be $\sqrt{2}$ or 1.41 times the voltage of either phase, and when the system is balanced the current flowing in the line, 2, will also be $\sqrt{2}$, or 1.41 times the current

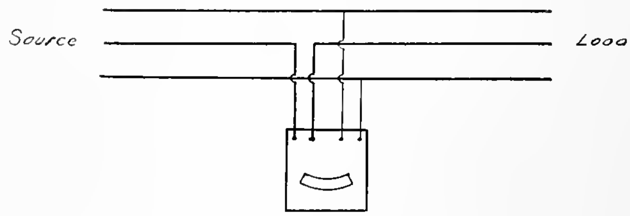


Fig. 9.

in either phase. The one wattmeter method will measure the true power only when the phases are perfectly balanced, and is therefore very seldom used.

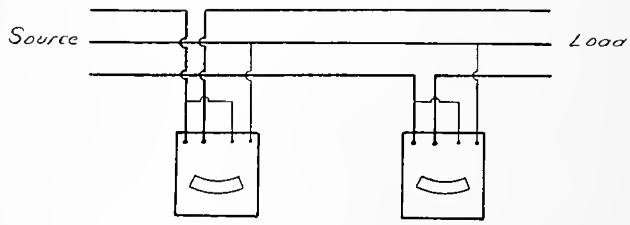


Fig. 10.

The power flowing in a three-phase system can be measured by two single-phase meters connected as shown in Fig. 10, or by one polyphase meter connected as shown in Fig. 11.

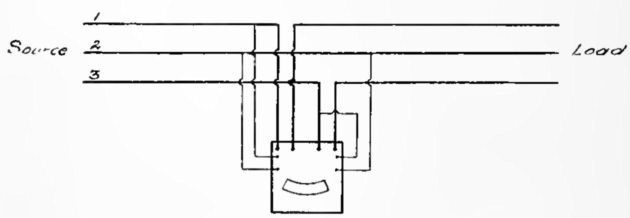


Fig. 11.

The power in a three-phase four-wire system can be measured by three single-phase wattmeters connected as shown in Fig. 12; the three-phase four-wire system being virtually three single-phase systems. The

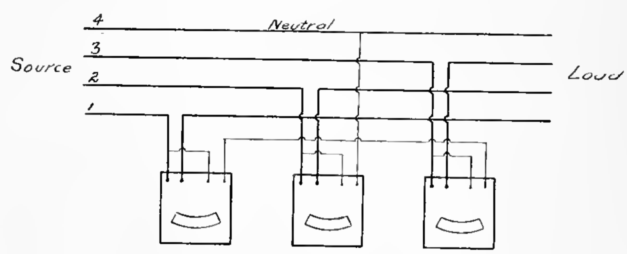


Fig. 12.

total power will be the sum of the indications of the three meters. The power in a three-phase four-wire system can also be measured by two single-phase meters connected as shown at (a) in Fig. 13, or with

one polyphase meter in conjunction with current (or series) transformers connected as shown at (b) in Fig. 13.

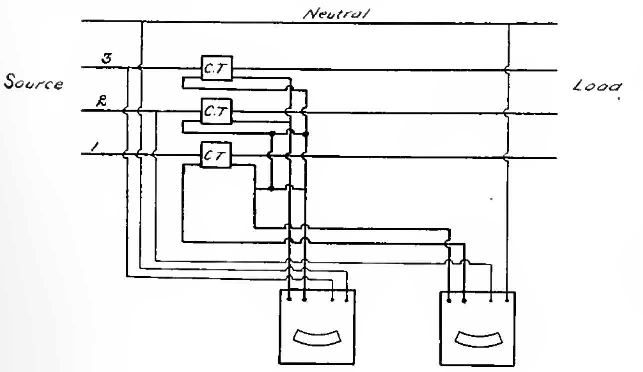


Fig. 13a.

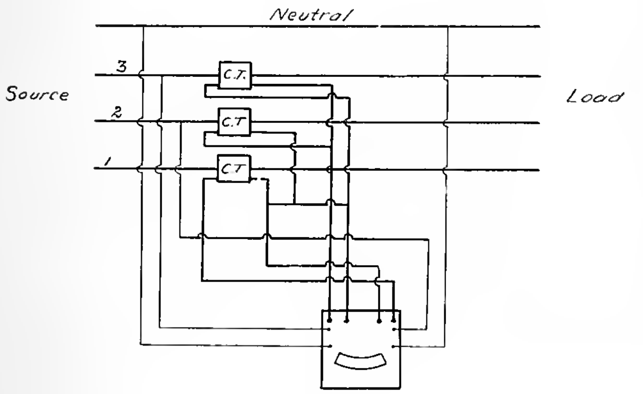


Fig. 13b.

The power flowing in a three-phase system is expressed by the equation, $P = \sqrt{3}$ EI, cos θ, where E is the voltage between the phases, I the current per leg and cos θ, the power factor of the circuit, When the system is not balanced the average values of the current, the voltage and the power factor should be used in the above equation, remembering that θ is the angular displacement between the line current and the voltage between line and neutral.

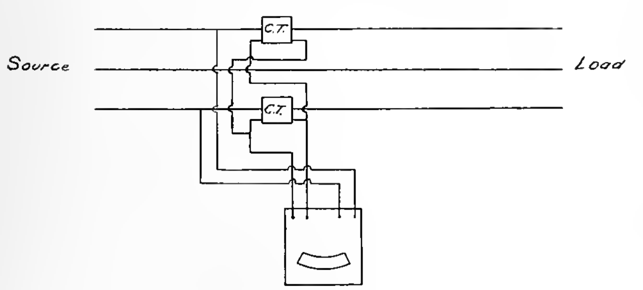


Fig. 14.

Fig. 14 shows the method of connecting one single-phase wattmeter for measuring the power in a balanced three-phase three-wire system.

Power is the rate at which energy is supplied. Electrical power is measured in watts and kilowatts, and electrical energy is measured in watt-hours and kilowatt-hours. "Purchasers of power" are in reality purchasers of energy, and in order to determine the energy flowing in a circuit it is necessary that the power be multiplied by the time. If w = the power in kilowatts, and t = the time in hours during which the power is flowing, then the energy = w t = kilowatt-hours. Since it is energy and not power which is bought, it is necessary to have an instrument which will take into consideration the time element; such an instrument is the watthour meter.

(TO BE CONTINUED.)

MUKDEN ELECTRIC-LIGHT PLANT.

Vice-Consul-General F. D. Cloud furnishes the following information concerning the electric lighting of Mukden. The Mukden electric-light plant was installed by the Chinese local government in connection with the government's provincial mint on Oct. 1, 1909. According to the original plans the plant was to have been of only 5000 lamps capacity. Recently, however, the management decided to enlarge the plant of 15,000 lamps, and has already placed orders for the additional machinery and materials. The total cost of the plant when completed will be approximately $165,000 American currency, of which amount an American firm will supply about $115,000 worth of materials and machinery. The entire installation has been under the supervision of an American engineer employed by the Chinese Government.

The plant is affording a most satisfactory service and, for this part of the world, at very reasonable rates. The popularity of electricity among the Chinese as a means of lighting has again been fully demonstrated by the eagerness with which the inhabitants of Mukden are clamoring for lights.

The following is a schedule of the new concern's lighting rates—flat-rate system—per month: Carbon filament lamps: eight candlepower, 54 cents; 16 candlepower, 90 cents. Metallic filament lamps: 20 candlepower, 90 cents; 30 candlepower, $1.34; 50 candlepower, $1.80; 80 candlepower, $2.24. Lamps will be paid for and owned by the customers. Wiring and pendant fittings will be installed for 23 cents each.

Meter-rate system: Per kilowatt-hour (1000 watts for a period of one hour), 11 cents; meter rental, on bills less than $9, 45 cents per month. Ten lamps or more will be required for each meter. Wiring and fittings will be installed at cost price, and the material will be the property of the customers. The installation cost per pendant lamp will be from $1.35 to $2.25 each, varying as the distance between lamps increases and the number of lamps decreases.

Discount on bills per month: Five per cent during the first five days of succeeding months; five per cent on all bills over $22; 10 per cent on all bills over $45; 15 per cent on all bills over $67.

Safety Appliances for Electrical Workers was the subject of an address by Dr. William H. Tolman, director of the Museum of Safety and Sanitation of New York, in the Western Society of Engineers' rooms, Chicago, February 14th. Dr. Tolman has returned recently from a visit to the museums of safety of Budapest, Paris, Munich, Berlin and Vienna, and discussed both foreign and domestic safety precautions. Incidentally, he mentioned the importance of protecting electrical workers called upon to handle charged conductors and "dead" conductors that may become "alive."

REPORT UPON PACIFIC T. & T. CO.

BY C. L. CORY.

To the Honorables, The Mayor and The Board of Supervisors, of the City and County of San Francisco, San Francisco, Californai.

Gentlemen:—In compliance with your resolution No. 4100 (New Series) dated June 30, 1909, I have made a personal inspection and examination of the complete equipment of The Pacific Telephone and Telegraph Company in San Francisco, including its books, records, engineering data, etc., and beg herewith to submit the following:

REPORT.

The information required by your resolution is included under three headings, as follows:

I. The true valuation of the entire installation of The Pacific Telephone and Telegraph Company in San Francisco on July 1st, 1909, and also all additional investments which properly belong to extensions and additions to the system in San Francisco during the period from July 1st, 1909, to January 1st, 1910.

II. The average number of telephones operated by the company in San Francisco for each month of the year 1909, the additional telephones installed during each month of the year, and the average revenue to the company per telephone.

III. The total annual revenue and expenses of The Pacific Telephone and Telegraph Company in San Francisco for the year 1909, including a proper segregation of accounts showing separately the revenue from local and long distance service, and the expenses of operation, maintenance, repairs, instrument rental, etc.

I.

Valuation of Plant.

In determining the valuation of the plant of the company on January 1, 1910, the complete inventory of the general plant on July 1, 1908, of The Pacific Telephone & Telegraph Company actually required and used in its San Francisco business as set forth in summary on page 6 of the printed report submitted by me on February 9, 1909, to the Mayor and Board of Supervisors of the City and County of San Francisco,[1] has been used as a basis. Reference to this report shows that the inventory as of July 1, 1908, was made jointly by representatives of the company and myself and these inventories were compiled in forms which were checked and verified by me.

On page 6 of the above mentioned report the additions to the plant of the company from July 1, 1908, to January 1, 1909, are also given in detail, as well as the valuation of the plant on January 1, 1909, which is copied below from the above mentioned report. The total investment represented in the various portions of the plant on January 1, 1910, also on July 1, 1909, and the increase in investment during the first six months and also the last six months of 1909, are given below.

EXCHANGE PLANT, SAN FRANCISCO, CALIFORNIA.

	Valuation Jan. 1, 1909.	Valuation July 1, 1909.	Valuation July 1, 1910.
Real estate	$ 929,479.12	$ 985,619.71	$ 966,462.61
Exchange—Pole lines ..	285,461,53	317,399.95	318,718.28
" —Right of way	37,877.30	40,809.56	42,444.29
" —Aerial cable..	348,371.00	475,610.57	496,604.42
" —Aerial wire.	285,963.75	320,556.15	291,600.78
" —Underground conduit ..	1,244,246.04	1,276,054,61	1,311,616.69
" —Underground cable	1,432,760.13	1,518,258.21	1,558,853.27
" —Central office equipment	1,111,780.58	1,251,573.85	1,384,397.88
" —Subscriber's' stat. equip	883,985.57	1,030,081.30	1,177,973.10
Construction in process	15,089.99	70,929.30	70,017.92
Furniture and fixtures..	22,623.96	33,253.47	44,453.10
Tools and teams	48,650.79	50,476.37	52,777.82
Supplies	121,981.06	102,477.27	155,433.11
	$6,768,270.82	$7,446,100.32	$7,871,353.27

[1]See Journal of Electricity, Power and Gas, Mar. 13, 1909, for previous reports.

The following summary gives the total investment in, or valuation of, the plant in San Francisco on January 1, 1909; July 1, 1909; January 1, 1910; and also all additional investments belonging to extensions and additions to the system for the six months from January 1, 1909, to July 1, 1909; from July 1, 1909, to January 1, 1910; and also for the full year 1909:

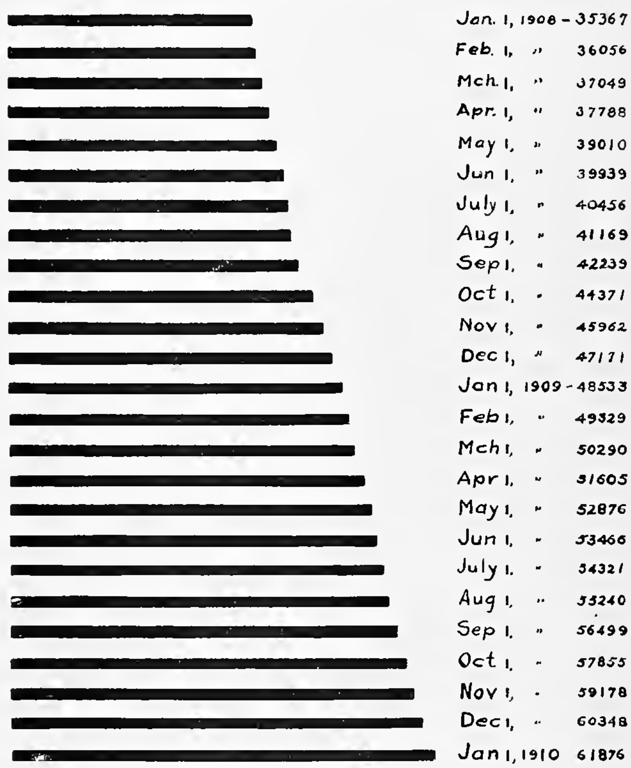
Valuation of plant January 1, 1909................	$6,768,270.82
Valuation of plant July 1, 1909....................	7,446,100.32
Valuation of plant January 1, 1910	7,871,353.27
Additions to plant January 1 to July 1, 1910......	677,829.50
Additions to plant July 1, 1909, to January 1, 1910...	425,252.95
Additions to plant for the entire year 1909	1,103,082.45

II.

Number of Telephone Stations and Average Revenue.

The number of telephones installed and in operation January 1, 1909, as given on page 6 of my previous report was 48,533. The number of telephones installed and in operation on January 1, 1910, the number connected, disconnected,

Chart Showing Increase In Number of Telephones In San Francisco During 1908 and 1909.



and the net gain for each month during the year 1909, and also the number of telephones in operation on the first of each month of 1909 are given below:

	Connected.	Disconnected.	Net Gain.	1st of Mo.
January	1284	488	796	*48,533
February	1576	615	961	49,329
March	2295	980	1315	50,290
April	2036	765	1271	51,605
May	1703	1113	590	52,876
June	2014	1159	855	53,466
July	1800	881	919	54,321
August	2423	1164	1259	55,240
September	2491	1235	1356	56,499
October	2213	890	1323	57,855
November	2122	952	1170	59,178
December	2634	1106	1528	60,348
	24,691	11,348	13,343	

Total stations January 1, 1910 ....**61,876

*Including 508 Private Branch Switchboard Stations.
**Including 654 Private Branch Switchboard Stations.

From these figures it will be seen that the net gain in telephones in operation for the year 1909 was 13,343, which is a gain of 27.5% over the number in operation on January 1, 1909. The corresponding increase for the previous year, 1908, was 13,166 telephones, which was a gain of 37.2% over the number in operation on January 1, 1908.

The number of telephones in operation on the first of each month, beginning January 1st, 1908, and ending January 1, 1910, is represented graphically by the accompanying chart.

The average revenue per telephone for each month during the year 1909, and also the average revenue per telephone for the first six months and for the last six months during 1909 is shown in the following statement.

MONTHLY STATEMENT OF STATIONS IN SAN FRANCISCO FOR 1909.

Month.	Number on 1st.	Net gain during Month.	Average for Month.	Revenue from Stations.	Ave. rev. per Station.
January	48,533	796	48,931	$185,092.48	$3.783
February	49,329	961	49,809	176,203.80	3.537
March	50,290	1315	50,948	191,201.53	3.753
April	51,605	1271	52,240	196,250.65	3.757
May	52,876	590	53,171	194,213.05	3.653
June	53,466	855	53,993	197,089.75	3,650
July	54,321	919	54,781	190,171.33	3,471
August	55,240	1259	55,870	196,225.32	3.512
September	56,855	1356	57,177	198,575.78	3.473
October	57,855	1323	58,516	208,831.04	3.569
November	57,178	1170	59,763	209,074.85	3.498
December	60,348	1528	61,112	209,593.31	3,430

Average revenue per station, Jan. 1 to June 30, 1909......$3,689
Average revenue per station, July 1 to Dec. 31, 1909...... 3,492

The average revenue per station as given is obtained by dividing the total revenue from local telephone service for each month of the year by the average number of telephone stations, including extensions, private branch exchange stations, dead-head telephones, etc.

The average revenue per station from January 1 to June 30 and from July 1 to December 31 for 1908, and also for 1909, is as follows:

1908—January 1 to June 30	$4.233
" —July 1 to December 31	3.714
1909—January 1 to June 30	3.689
" —July 1 to December 31	3.492

The reduction of the average revenue per station from $4.233 for the first six months of 1908 to $3.714 for the last six months of 1908 is due in part to the reduction in rates which took effect on July 1, 1908, and also partly due to the increase in the number of telephones in operation during the last six months of the year as compared with the number of telephones during the first six months of the year. On the other hand the reduction in the average revenue per station from $3.714 from July 1st to December 31, 1908, to $3.689 during the period from January 1st to June 30, 1909, is due solely to the increase of the number of telephones in operation. Similarly, the reduction in the average revenue from $3.689 for the first six months of 1909 to $3.492 for the last six months of the same year is due both to the reduction in rates taking effect July 1, 1909, and to the increase in the number of telephones in operation during the last six months of the year as compared with those in operation during the first six months of the year.

The average revenue per station for the different classes of service during December, 1907, 1908 and 1909 is given below, showing the effect of the reduced rates which began July 1, 1908, the rates being still further reduced, beginning with July 1, 1909.

	December 1907.	December 1908.	December 1909.
Business Measured.			
Number of stations	1,989	2,702	3,452
Total revenue	$26,240.02	$32,936.26	$35,017.48
Average revenue per station	$13.19	$12.19	$10.14
Business Prepayment. (Nickel in Slot.)			
Number of stations	7,716	9,690	9,916
Total revenue	$48,847.50	$58,933.05	$56,551.82
Average revenue per station	$6.33	$6.08	$5.70
Residence Unlimited.			
Number of stations	5,823	8,010	7,262
Total revenue	$22,107.50	$24,829.15	$23,238.55
Average revenue per station	$3.80	$3.10	$3.20
Residence Measured.			
Number of stations	(None)	447	3,032
Total revenue		$ 1,309.15	$ 8,800.98
Average revenue per station		$2.93	$2.90
Residence Prepayment.			
Number of stations	7,427	9,219	13,301
Total revenue	$12,537.10	$16,302.25	$23,321.82
Average revenue per station	$1.69	$1.77	$1.77
Private Branch Exchange.			
Number of stations	7,778	11,398	16,228
Total revenue	$25,330.56	$30,136.30	$41,079.87
Average revenue per station	$3.25	$2.64	$2,53
Extensions.			
Number of stations	3,280	5,604	5,433
Total revenue	$ 3,268.65	$ 2,811.50	$ 2,743.73
Average revenue per station	$1.00	$0.50	$0.50
Miscellaneous.			
Number of stations	491	675	1,642
Total revenue	$ 5,819.36	$ 6,337.19	$ 6,135.40
Average revenue per station	$11.85	$9.39	$3.74

III.

Cost of Operation.

Following the classification used by the company at the present time in keeping their accounts, the statement of earnings and expenses for the year 1909 is segregated as follows:

Revenue.	6 months ending June 30, 1909.	6 months ending Dec. 31, 1909.	Totals Year 1909.
Local	$1,140.051.26	$1,212,471.63	$2,352,522.89
Private line	13,341.90	6,596.86	19,938.76
Long distance	36,180.16	39,535.15	75,715.31
Total	$1,189,573.32	$1,258,603.64	$2.448,176.96
Expenses.			
General	$ 42,922.39	$ 51,447.86	$ 94,370.25
Operating	314,348.60	373,773.25	688,121.85
Maintenance—Repairs	163,691.66	167,357.74	331,049.40
" —Removing.	99,893.40	111,397.84	211,291.24
" —Depreciatn	147,648.23	160,498.30	308,146.53
Instrument rental	52,195.31	55,134.56	107,329.87
Conduit, pole & roof rent	392.41	627.39	1,019.80
Insurance—Per. property	7,764.62	6,735.44	14,500.06
" —Real estate..	2.382.99	2,000.15	4,383.14
Taxes—Per. property...	28,898.02	31,492.38	60,390.40
" —Real estate	3,723.86	4,734.27	8,458.13
Total	$ 863,861.49	$ 965,199.18	$1,829,060.67
Net Revenue	$ 325,711.83	$ 293,404.46	$ 619,116.29

An analysis of the above statement of expenses is in conformity with the segregation of accounts which is outlined in my previous report filed with the Clerk of the Board of Supervisors cn February 9, 1909, as set forth on pages 9, 10 ond 11 of said report. Certain minor changes have been made during the past year in a few of the sub-headings, but these minor changes are unimportant, and conform in practically every detail with the recommendation made by me regarding the form of statement, etc., in the former report above referred to. The gross revenue, expenses and net revenue of the company for both 1908 and 1909 are given below:

1908—Gross revenue	$2,150,734.09
" —Expenses	1,603,552.06
" —Net revenue	$ 547,182.03
1909—Gross revenue	$2,448,176.96
" —Expenses	1,829,060.67
" —Net revenue	$ 619,176.29

The Pacific Telephone & Telegraph Company have since July 1, 1908, kept a separate and complete set of books to separately cover the accounts for San Francisco. As a result the work of segregation of accounts, both as regards new construction and gross revenue, expenses and net revenue, has been readily and accurately done.

In conclusion, I am glad to acknowledge the many courtesies extended to me by the officials of the company in connection with the preparation of this report. Data and information which I have requested have been given me in great detail, and the officials of the company with whom I have worked have offered me every facility possible.

STEAM

RAPID INSTALLATION OF A STEAM TURBINE AT OAKLAND.

BY F. H. VARNEY.[1]

On the 6th of July, 1908, the management of the Pacific Gas and Electric Company requested that the matter of a 9000 k. w. turbine installation in Oakland be given consideration and attention. The choice of a prime mover rested between two types of turbine—the horizontal and the vertical. After the question of prompt delivery and the relative merits of both types had been fully considered, the Curtis vertical turbine, built by the General Electric Company, was chosen.

This decision was reached about the middle of July, and orders were received to have the plant in operation for the Christmas load. The engineering department, therefore, had to undertake to design, construct, and place in operation a complete turbine plant in one hundred and sixty-two days.

It is hard for those whose avocations lie in fields other than technical to appreciate the immense amount of detail involved in an engineering problem of this nature. Preliminary surveys must be made; preliminary plans drawn and submitted for approval. Then come the working drawings., These in turn must be examined, and any changes made before it is too late. For it must be remembered that once the engineer's thoughts have been translated into concrete, iron, and steel they can not be revoked at any future session; his work must stand as a monument to either his ability or his incompetency.

All branches of the department were now actively engaged in preparing their particular portions of the work. The preliminary labor had been completed and approved; the finishing touches were being given to the working drawings; specifications were drawn up, and many a tiny lamp was burned long into the small hours of the morning because of an earnest endeavor that no detail should be overlooked. In due time all the plans and specifications were completed and approved, and the contracts were awarded and signed. Some of the contractors, who were never known to make deliveries in less than nine months, fairly gasped when they were informed what was required of them. But on account of the heavy bonus and the penalty attached to each contract, they determined to strain every effort to complete the contracts on time.

The engineer can not lose sight of certain given factors, and while promises are made in perfectly good faith, their fulfillment may be indefinitely deferred on account of apparently insurmountable obstacles. An engineer in charge of work must be everywhere; must anticipate delays, and be ready to step instantly into the breach with a solution; he must have an accurate knowledge of human nature, and be able to swing troublesome contractors into line; he must be, in truth, the coacher of the team. It is gratifying to know that with our organization, the personnel of those in charge, both in the office and in the field, and the esprit de corps, which makes possible the existence of that great fundamental principle of success—team work—we were able to complete the turbine installation (from the first day of breaking ground to the time of actually operating the turbine under its own steam) in seven days less time than that set by the management.

While avoiding a purely technical discussion of the installation, it will be a matter of general interest more clearly to understand the many elements that are necessary to produce the salable product, electric energy.

Did you ever stop to consider what a mysterious and intensely interesting product it is? Unlike that of any other manufacturing concern, none of the employees has ever seen the product, yet it is handled in quantities large and small, and upon receipt of an order from a customer it can instantly be sent to him—by wire. The manufacturer of some powerful locomotive could take you to his factory and trace the development of his product from the raw material to the high-speed express engine. The manufacturers of electricity can show you neither the raw material nor the finished product. But we can take you to some rocky point overlooking one of the great reservoirs in the mountains and tell you that there are untold quantities of our product under the shimmering surface of the water. Or, standing in front of this great steam turbine in Oakland, we could tell you that our product is being manufactured at the rate of more than two hundred thousand units daily.

The turbine plant in Oakland, known as Station C, is situated on a part of the property of the Oakland Gas Light and Heat Company, a subsidiary company to the Pacific Gas and Electric Company. The property is bounded by First street, Grove street, Jefferson street, and the Oakland estuary. The steam turbine is the largest single-driven unit on the Pacific Coast. It occupies about one-tenth of the space required for a corresponding reciprocating engine plant of the same capacity. The advantages of this type of prime mover over the reciprocating engine are numerous. An interesting incident occurred in this relation worthy of comment. One of the problems that the operating engineer has to contend with in the use of the reciprocating engine is in jacking over the engine by hand, when it is necessary to do any overhauling work. The matter of providing the turbine with similar apparatus for turning it through part of a revolution caused us considerable thought, but one day, during the assembling of the turbine, we were surprised to see one of the erecting men climb into the ventilator flue at the top of the turbine and revolve the turbine with one hand. Some idea of the perfect balance of the turbine may be gained when it is stated that the revolving parts weigh seventy-two tons. Another interesting feature is that this entire weight is carried on a thin film of oil which is forced into the step bearing under a pressure of more than half a ton to the square inch.

The condenser, shown to the left of the turbine, is larger than the turbine itself, and if the tubes were withdrawn and placed end to end, they would extend for a distance of sixteen miles. A story is told of a

[1]The Pacific Gas and Electric Company's Engineer of Operation and Maintenance of Steam and Gas Engineering.

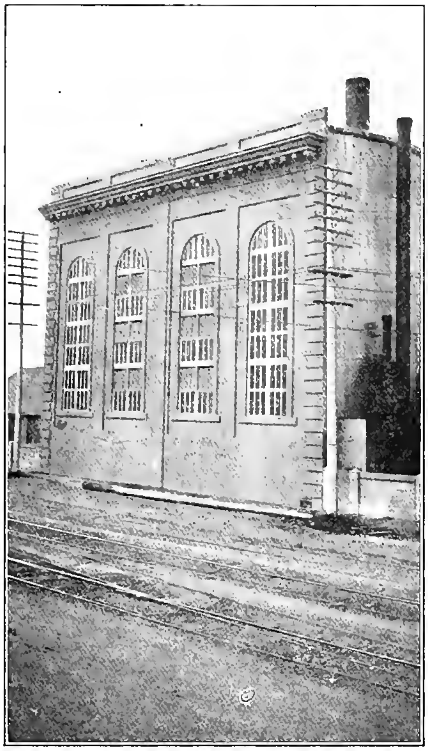
certain marine engineer. Upon his first visit to the station and first view of the condenser, he expressed his admiration for it, but was in doubt as to the use of the "small vertical thing" at the side of the condenser. This "small vertical thing," however, is capable of developing 12,000 h. p.

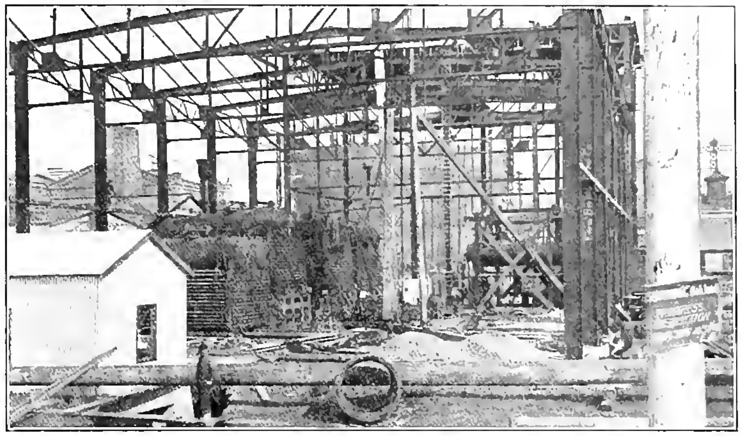
One of the greatest sources of worry to the engineer of the condensing plant is circulating water. "Losing the water," as it is termed, is a very serious matter, but owing to the precautions which have been taken at Station C this danger is far removed. A 42-in. pipe has been laid to the pier-head line in the Oakland estuary, and at the time of the lowest tide there is a trifle more than 6 ft. of water over the intake. By keeping the mud dredged away from the pump suction an ample supply of circulating water is assured.

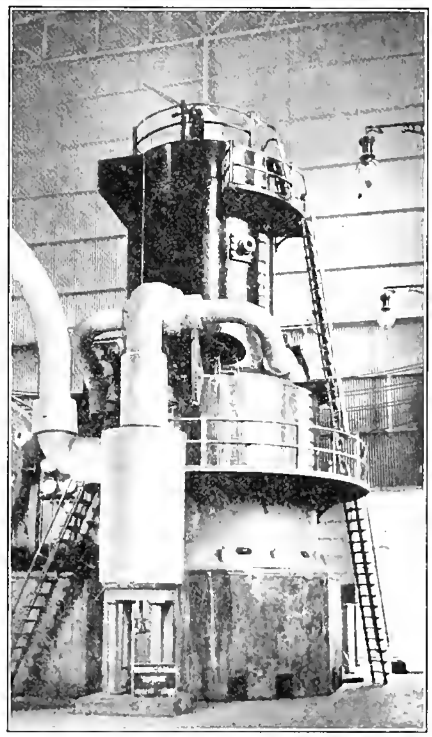
This sturdy unit of 12,000 h. p. is served by eight water-tube safety boilers, with superheaters, installed in batteries of two, and four in a row facing each other as will be noted in the illustration. Two sheet steel stacks, well guyed, rise to a height of one hundred and ten feet above the boiler-room floor, with ample capacity for four boilers each. The Hammel type of furnaces with return flame oil-burners are used throughout.

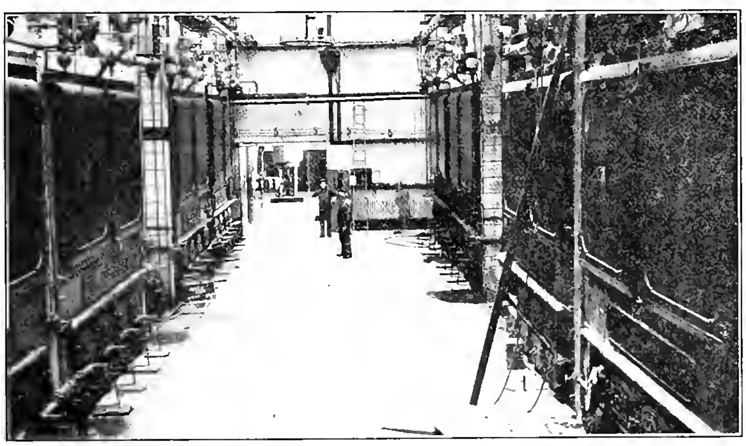
The visitor at Station C is impressed with the compactness of the installation. The turbine and its auxiliary apparatus is accessible at all points, yet the amount of waste room has been reduced to a negligible quantity.

Station C is entirely a generating station. The distribution station, with the necessary switchboards and high-tension switches, is an entirely separate building, known as Station A. The transmission station will adjoin it, and will be known as Station B, thus giving in Oakland three distinct types of stations: generating, distributing, and transmitting.









STATION C, OAKLAND
Showing Exterior, Station During Construction, 9,000 k.w. Curtis Turbine and Boiler Room.

THE LOW PRESSURE STEAM TURBINE.

Discussion by members of the San Francisco Section, A. I. E. E., January 28, 1910, of paper by E. O. Shreve, as published in this journal, February 19, 1910. The paper was followed by lantern slide talks by F. E. Vickers and K. G. Dunn. The following participated in the discussion:

C. W. Burkett, General Superintendent of Plant, Pacific T. & T. Co., San Francisco, Chairman.

A. J. Bowie, Jr., Electrical Engineer, San Francisco.

E. O. Shreve, Sales Engineer, General Electric Co., San Francisco.

K. G. Dunn, Vice-President, Hunt, Mirk & Co., San Francisco.

F. E. Vickers, Assistant Engineer. General Electric Co., San Francisco.

C. L. Cory, Professor of Electrical Engineering, University of California.

A. J. Bowie, Jr.: I would like to ask Mr. Shreve if there is any material gain in the economy of the low pressure turbine in super-heating?

E. O. Shreve: I think there is very little gained in that respect. If you take steam at 150 pounds pressure and reduce it through a reducing valve to atmospheric pressure to introduce into the turbine, you secure in the neighborhood of 100 degrees super-heat, which would give about 8% increase in economy on the turbine, this being more than offset by the loss due to decreased steam pressure. This is not exactly the case with the Curtis type of machine because both low pressure and live steam can be and are brought directly in contact with the revolving element. The low pressure steam being expanded through one set of nozzles and the high pressure through another. The increased velocity obtained by using high pressure steam in this manner will give a decrease in water rates of from 20 to 30%. This also allows non-condensing operation.

A. J. Bowie, Jr.: Taking the live steam direct, without counting with low pressure steam at all—is that what you mean? To turn a certain amount of live steam in the low pressure, not super-heating the low pressure steam.

E. O. Shreve: No; there is no added gain there. You are thinking of the feasibility or advisability of using live steam to get increased economy from the low pressure, it would be better to use the live steam in a high pressure turbine. The only reason we use high pressure steam at all is in case of over loads where we have insufficient exhaust steam, or in case of the necessity of shutting down the engine or other source from which the exhaust steam is obtained. Ordinarily it would not be good practice to put in a low pressure machine that would take a great deal of live steam. I would like to emphasize the fact that in the case of the installation of the Interborough Rapid Transit, that this gain was made without an increase in the boiler plant or the building at all, and with about half the total expenditure for the machinery installed that it would take for the original machinery, including boilers and the total installation.

E. O. Shreve: We have another installation at the E. K. Wood Lumber Company, in Bellingham, Washington, which would probably interest the local people, a 400 kw. mixed pressure machine, which takes exhaust steam from an engine carrying a variable load of about 300 h. p. to 750 h.p. The mixed pressure turbine is delivering power to a railroad and has a variable load of from 100 to 500 kw. This is a case with a variable load factor at both ends, and we have been able to get exceedingly satisfactory results from this installation. By installing the low pressure turbine in this particular instance they saved on their assumed cost of increase in capacity $10,000 approximately, and about 30% increase in efficiency. Besides that they have an additional advantage in this particular case, of using the condensing water to take away their refuse saw-dust and shavings. This turbine is designed to carry full load on either exhaust or live steam or both, and will deliver a large percentage of its rated capacity when operating non-condensing.

K. G. Dunn: On that question, steam expanding without doing work super-heats. Expanding from 150 pounds to what is used in the turbine would super-heat 60 to 70 degrees. This, alone, would give an increased economy of say 6 or 7 per cent. This would amount on a turbine over what we would get using saturated exhaust steam to 8 or possibly 9 per cent, due to the entrainment of the moisture in the exhaust steam.

With the admission valve as shown on the Westinghouse exhaust turbine full load could be carried with this admission valve admitting live steam. The governor would automatically open and allow the necessary pressure to be built up, when the supply of exhaust steam was insufficient. In fact the pressure would build up sufficient so that the machine could be operated non-condensing and carry full load. Under emergency conditions this feature is of great value in the plant.

I would like to take exception to a remark Mr. Shreve made in the early part of his paper, in which he stated that a 22 and 44 x 42 engine, 150 pounds, and 26 inches vacuum would rate at 1250 kw. The economy was 23 pounds per i.h.p. condensing, and 35 non-condensing. I think any Corliss engine man that you would talk to about a compound engine at 23 pounds per i.h.p. condensing would think it was a bum engine. He would realize that about 27 to 30 pounds mean effective pressure referred to the low pressure cylinder would be the most economical point. If Mr. Shreve will point out an example where they make large gains by combining an exhaust turbine with a conservatively rated engine, I would not take exception to it, but the mean effective pressure of this engine referred to the low pressure cylinder, to produce the rating given is over 50 pounds. He might just as well have taken a simple engine in which he would get about those results and be done with it, instead of tryingg to compare it with what we might say was a high grade engine. That is not a typical result, and the saving in fuel could not be produced with a high grade compound engine, operating at or about its economical rating.

E. O. Shreve: I wish to correct an apparent misunderstanding there. The water rate referred to 23 and 35 pounds condensing and non-condensing respectively, and were taken from actual tests. It is but one of many such instances where gains of this amount have been made.

K. G. Dunn: Even on that basis you would have over 50 pounds mean effective pressure referred to the low pressure cylinder when operating condensing. A conservative rating would not exceed 30 pounds, so you see the engine would be heavily overloaded, when delivering 1200 kw,, and the water rates given could not be obtained at 1200 kw. load. A conservative rating on that engine would not exceed 750 kw., instead of 1200, and to produce the results shown the engine would cut off at about 90% stroke. This is simply a case of taking the engine water rate at over loads, and comparing with combined results at most favorable load, a disguise of the true gain.

Mr. Miller: The Salt Lake plant contains an old Corliss engine 30 by 60, 60 revolutions, and is rated about 1200, and by the addition of a low pressure turbine of 1000 kw. capacity the power of the installation is increased about 60 per cent on the same fuel consumption. The equipment consists of 4000 square feet surface condensing. The circulating pump is a rather interesting thing, and is driven with an Alberger turbine. The Alberger condenser turbine is a single stage affair, but uses the steam over again three or four times on account of the internal arrangement of the plating. This machine of course has a governer, on account of being connected—having a mixed pressure arrangement.

Question: In these increases in power and economy is any allowance made for the power and steam used for running the condensing apparatus?

F. E. Vickers: At the Interborough plant in New York, the 20% gain in station economy due to the installation of their 5000 kw. Curtis low pressure turbine was measured at the coal pile, and therefore includes all power required for auxiliaries

C. L. Cory: For the man who is responsible for the reliability of service, the addition of low pressure steam turbines to

existing engines is very much in his favor. We know how difficult it is to adapt many existing plants that may be operating in parallel to a load where the load factor is widely variable during the day; and from what has been told us this evening about the possibility of a mixed pressure turbine, it is quite evident that with reciprocating engines of high average economy it is possible with a combination engine and turbine plant to get very high economy, at the same time have a plant capable of great flexibility of operation. If for instance we take, not an inferior but a very good compound condensing reciprocating engine plant, and increase the capacity, possibly for peak load only, by adding low pressure turbines, we are not only not increasing (as has been said) the size of the plant with no addtional investment in boilers, and not increasing the fuel bill, but we are increasing the peak load capacity and if necessary we can use the turbine as a high pressure turbine, or as a low pressure turbine, or perhaps use it as a combination of the two. We are not only increasing the peak load capacity, but we are increasing the avęrage economy of the plant throughout the twenty-four hours, perhaps above some of the comparative curves shown by Mr. Dunn. There is one thing that must not be forgotten which was brought out by Mr. Dunn's curves. A high vacuum is absolutely essential. I could not help but think that the question was rather pertinent this evening when it was asked whether these economies expressed in percentages were obtained after the cost of the production of vacuum had been included. The necessary high vacuum sometimes costs not only energy for operation, but may require additional investment for the supply of a sufficient amount of cold water.

K. G. Dunn: On the question of vacuum, we once received a letter asking about a steam turbine, and the party said he understood it took a whole river of water to condense the steam from a turbine. Now steam from a turbine has no more heat units in it for a given vacuum than steam from a steam engine. Therefore it takes no more water to condense steam at a given vacuum from a turbine than from an engine. Any high vacuum apparatus for a large sized installation favorably situated for circulating water will take in the neighborhood of 5 per cent of the total amount of steam generated. It is a very simple matter to calculate as to what that gain is. If you gain 5 per cent in fuel per increased inch of vacuum and your total amount of power to secure high vacuum is 5 per cent, it does not seem that the high vacuum apparatus is an expensive addition to the plant. In fact it is advisable to get as high a vacuum as you can. Some people are under a misapprehension as to the reason why it is advantageous to have high vacuum for a turbine. A good cross compound engine will expand down to the neighborhood of 5 or 6 pounds absolute. High vacuum does not allow of more expansions in the engine but simply lowers the back pressure, the number of expansions being fixed by the cut off and cylinder ratios. Now the turbine is capable of expanding down to the lowest limit, and therein lies the increased economy of the turbine. There is no question but what the economy of the steam engine from the ordinary boiler pressures to atmosphere is superior to the turbine from boiler pressures to atmosphere; and also there is no question but what the turbine is more economical from atmospheric pressure to any commercial vacuum.

I would like to pass a remark also to prevent a misconception of the economies shown in the combination of low pressure turbines and engines. Some might get the idea it would be a good proposition to buy new engines and put exhaust turbines on them. I doubt this very much, although there are some engineers who are really in favor of this proposition. But I think if you will figure out the first cost of the installation, the additional cost of operation necessary with such a combination; these additions being due to extra labor, extra repairs, lubricating oil and so forth; that you will find it is a dubious investment, and you would be better off to install a complete, straight expansion turbine plant instead of a new combination reciprocating engine and low pressure turbine plant, on account of the increased fixed charges.

PRACTICAL MECHANICS, PAPER NO. 9.

(Belting—continued).

In addition to the advantage belting affords in effecting power transmission through long distances (as compared with rolling friction) there is a gain in frictional resistance due to the belt surrounding a large part of the pulley. This results in a greater turning effort at the driven pulley than would be possible with the mere line contact of two discs rolling together; or, as is really done—the same power is transmitted with much less bearing friction. In the following mathematical development of the laws of belting—tensions, power transmitted, etc., this increase in efficiency will be shown.

For the purpose of our discussion let

T_1 = the tension on the tight side of an endless belt.

T_2 = the tension on the loose side of the belt.

α = the angle of contact of the belt on the pulley.

ϕ = the coefficient of friction between the belt and pulley.

F = the total frictional resistance—i. e., the value, at the pulley circumference of the maximum adhesion between the belt and pulley.

K = the force to be transmitted, which must obviously be less than F else there would be slipping of the belt.

p = maximum allowable belt tension per inch of width.

W = the belt width in inches.

Before proceeding further a word in explanation of this term coefficient of friction may help to fix it clearly in mind. Suppose a smooth block of wood to be lying on a smooth table. The weight of this block acts as a force pressing it vertically downward against the table. Now if a cord were attached to the block and a spring balance fastened to it a certain number of pounds pull applied to the balance would cause the block to begin to slide along the table. Suppose the block weighed 4 lbs. and that it required 1 lb. at the balance to draw the block along the table. The ratio of this force to the weight or ¼ would be the coefficient of friction for these surfaces. In the case of two bodies rolling together (see paper No. 7) the force P pressing the two axles together corresponds to the weight of the block in our illustration, while K, the force which drives the follower is comparable to the tension in the cord as measured by the spring balance. In belting the effect of this coefficient of friction is greatly increased over what it would be if the pressure between shafts were applied simply to a flat belt surface resting on a metal surface. This is due to the varying tension in the belt as it goes around the pulley from the loose to the tight side.

This relation between the contact friction and the belt tensions can be shown, by taking the summation of the effects for small portions of the circumference to be $\frac{T_1}{T_2} = e^{\alpha\phi}$ (e here being the mathematical constant 2.71828 or base value of the Naperian logarithmic system).

This expression $e^{\alpha\phi}$ need not be feared by those not familiar with the use of the calculus as it will be conveniently disposed of before we reach our practical working formulas.

Now $F = T_1 - T_2$, the difference in tension between the two sides of the belt, since this difference is due to the frictional resistance between the belt and pulley.

Now K, the force to be transmitted, being less than F may be called equal to CF, where C is a slip safety factor, i. e. C is the per cent of the total force necessary to slip the belt, which is used to transmit power.

Thus: $K = CF$

or $K = C\ (T_1 - T_2)$ since $F = T_1 - T_2$

$= C\ (T_1 - \frac{T_1}{e^{\alpha\phi}}$ substituting for T_2 its equivalent value from the equation $\frac{T_1}{T_2} = e^{\alpha\phi}$

or $T_2 = \dfrac{T_1}{e^{\alpha\phi}}$ This equation it will be seen gives the force transmitted, K, in terms of the belt tensions and frictional values.

In order to put our belting calculations to practical use they must be reduced to terms of horsepower, belt speed in feet per minute and belt widths in inches.

Now the horsepower transmitted by belting may be expressed thusly: H. P. $= \dfrac{V \times K}{33000}$ i. e. the velocity in feet per minute multiplied by the force transmitted, gives the foot lbs. of energy, which, divided by the number of foot lbs. per minute in a horsepower gives the number of horsepower.

Solving this algebraically for W gives

$$W = \frac{33000 \times \text{H. P.}}{V\,C\,p\left(1 - \dfrac{1}{e^{\alpha\phi}}\right)}$$

For leather belts on iron pulleys the value of ϕ the coefficient of friction has been found by experiment to lie between .56 for dry surfaces and .15 for oily surfaces, average conditions giving from .25 to .30 h.p. Let us therefore take $\phi = .25$ as a conservative value. α, the angle of contact will be in cases of power transmission approximately 180°, i. e. the belt will cover one-half the pulley. A fair value for Cp is 55 for double leather belting. This

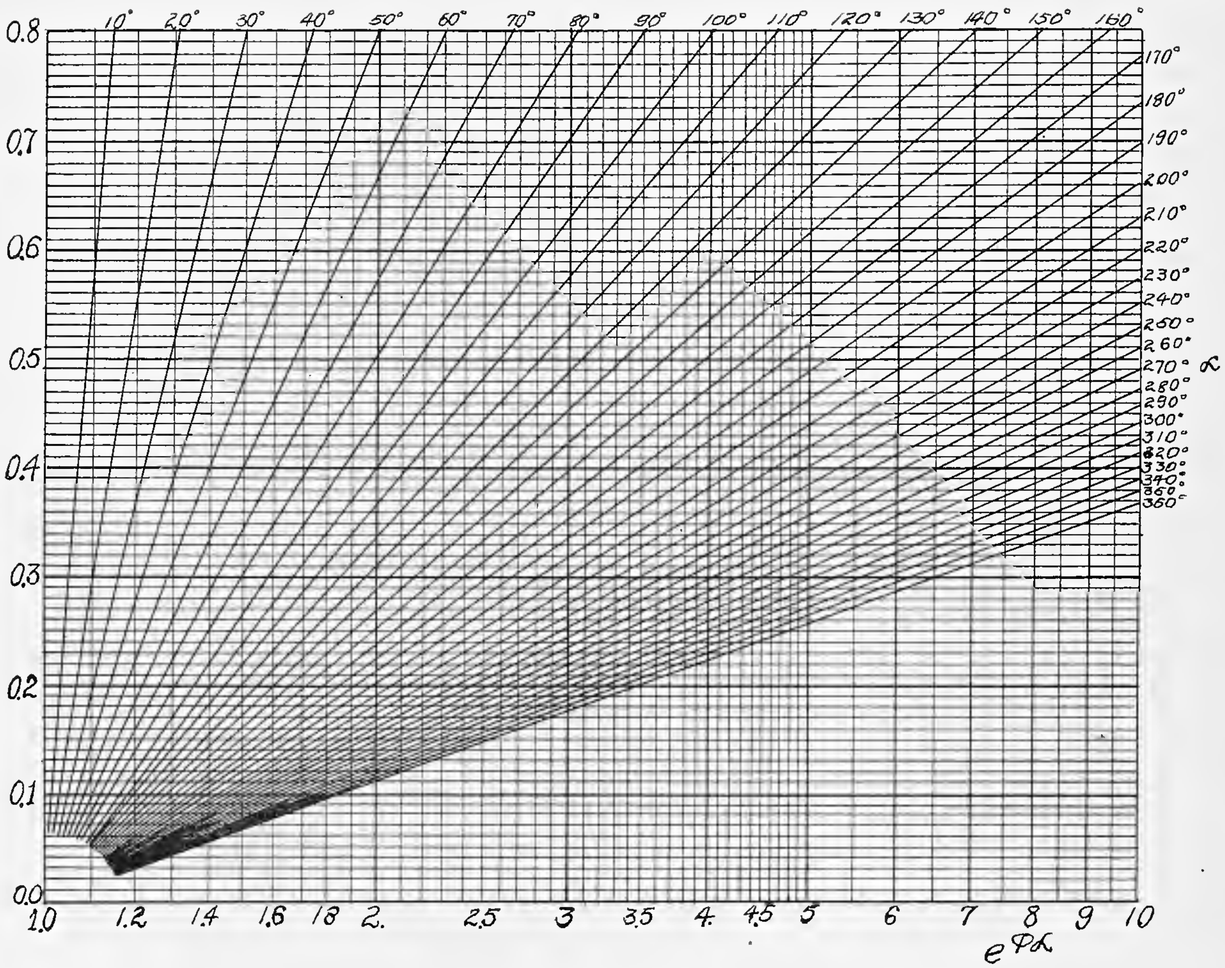


Diagram for Belting Computation.

But we have a value for K in an equation above. Substituting this gives

$$\text{H. P.} = \frac{V\,C\left(T_1 - \dfrac{T_1}{e^{\alpha\phi}}\right)}{33000} = \frac{V\,C\,T_1\left(1 - \dfrac{1}{e^{\alpha\phi}}\right)}{33000}$$

By inspecting this equation it will be noted that the horsepower and the velocity are variable terms while the remaining factors are all constant for a given belt and pulley.

Now if p = maximum allowable belt tension per inch of width then $p \times W = T_1$ the maximum tension for the whole belt width.

Putting therefore $p\,W$ for T_1 in the above question we have

$$\text{H. P.} = \frac{V\,C\,p\,W\left(1 - \dfrac{1}{e^{\alpha\phi}}\right)}{33000}$$

constant includes the safety factors of both strength and slip, being the product of the maximum tension per inch width and the per cent of the actual force necessary to produce slipping.

Thus if 70 lbs. were the maximum allowable strain per inch of width then $C \times 70 = 56$ when C is taken as .80 or 80% of the force necessary to slip the belt.

We now have all factors in the above equation with the exception of $e^{\alpha\phi}$.

In order to avoid the calculation involved in this term a diagram has been worked out by means of which the value of $e^{\alpha\phi}$ may be easily and instantly found for any usual values of ϕ and α. This diagram may be found in Le Conte's "Mechanics of Machinery" and is here reproduced as it appears in that work. The ordinate values on the left are values of ϕ ranging as seen from 0 to .0. Values of α from 0 to 360° are drawn radiating from the lower left hand corner of the diagram while

the resultant values of $e^{a\phi}$ are drawn vertically as shown by the abscissae scale at the the bottom. To determine $e^{a\phi}$ for the above values $\phi = .25$ and $a = 180°$ start at the .25 line on the left and follow out till it intersects with the 180° line, then drop vertically to the bottom of the diagram where the value 2.20 will be found. In similar manner the value of $e^{a\phi}$ may be found for any usual values of the exponents.

We can now substitute the values in our last equation. Thus:

$$W = \frac{33000 \times \text{H. P.}}{V \times 56 \times \left(1 - \frac{1}{2.20}\right)}$$

which simplified gives

$$W = \frac{1060 \times \text{H. P.}}{V} \text{ or practically}$$

$$W = \frac{1000 \times \text{H. P.}}{V}$$

This will be recognized as the old belting rule: "A belt 1-in. wide travelling 1000 ft. per minute will transmit 1 h.p."

Thus it is found that by the use of the accompanying diagram the necessary belt width for transmitting any required horsepower at a desired belt velocity may be obtained. And this for any predetermined values of frictional coefficient and angle of contact. The working equation is best put into the form

$$W = \frac{33000 \times \text{H. P.}}{V \times C \times p \left(\frac{e^{a\phi} - 1}{e^{a\phi}}\right)}$$

Referring to paper No. 8 in the preceding issue it will be remembered that the relation

$$V = \frac{\text{r. p. m.} \times \pi \text{ D}}{12}$$

was developed. By substituting from the value of

$$W = \frac{1000 \text{ H. P.}}{V}$$

we get the relation.

$$V = \frac{3800 \times \text{H. P.}}{\text{D} \times \text{r. p. m.}}$$

the belt velocity in terms of horsepower pulley diameter in inches and speed of the pulley.

Prof. Le Conte ingeniously shows the ratio gained by belting over friction gearing as follows:

Let P be the pull between the shafts.

$$P = T_1 + T_2; \text{ when } a = 180° \text{ then } P = T_2 + T_2 e^{a\phi}$$

$$= T_2\left(e^{a\phi} + 1\right) \text{ or } T_2 = \frac{P}{e^{\phi a} + 1.}$$

$$\text{At point of slip } F = K = T_1 - T_2 \quad \text{or } K = T_2 e^{\phi a} - T_2$$

$$= T_2\left(e^{a\phi} - 1.\right)$$

$$\text{Hence } K = \frac{P\left(e^{a\phi} - 1\right)}{\left(e^{a\phi} + 1\right)}$$

Now if ϕ be taken as, say .28 from the diagram $e^{a\phi} = 2.41$

$$\text{or } K = P\left(\frac{2.41 - 1}{2.41 + 1}\right) = \frac{1.41}{3.41} P$$

$$= .413 P$$

Thus where the frictional coefficient is .280 between the belting material and metal, the belt going half way round the pulley so grips it that a force of .413 of the pull on the shaft would be required to slip the belt. Thus the gain is in the ratio of $\frac{413}{250}$ or nearly $1\frac{1}{2}$.

BOOKS RECEIVED.

Transactions of South African Institute of Electrical Engineers. Vol. 1, Part 1. Published by the Institute, Johannesburg, South Africa.

The initial number of this publication of the most recently organized association of electrical engineers contains the constitution and by-laws of the body, a list of the foundation members and minutes of the first annual meeting which was concerned with the formation of the Institute.

"Automobile Driving Self-Taught." "Ignition Timing and Valve Setting." By Thomas H. Russell; 222 pages each; 5½x7½ in.; leather bound. Charles C. Thompson, Chicago, Ill. ,and the Technical Book Shop, San Francisco. Price, $1.50 each.

Each of these books is written in an interesting manner by an authority on the subject of automobiles. The former contains suggestions on automobile driving which are as valuable to the expert as to the novice. The latter is primarily intended tor the man caring for his own car and is eminently practical. Both are well illustrated and printed.

Preliminary Report Utah Conservation Commission. 128 pages; 6x9 in., and map of Utah. Published for free distribution by the Utah State Conservation Committee, Salt Lake City, Utah.

The Utah State Conservation Commission was established by legislative act in 1909 and now consists of eight members including the Governor. This, their first report, tells of the natural resources of the State of Utah in addition to various suggestions as to how they may be best conserved. These resources are classified as land, water, mineral, food products, game and timber, the mineral predominating.

Engineering Diagrams. By Manifold & Poole. A collection of straight line diagrams assembled in a leather bound loose leaf note-book 4½x7½ in. Published by the Technical Book Shop, 604 Mission St., San Francisco. Price $3.00.

These diagrams are ingenious and convenient devices for rapidly calculating engineering problems. Their main object is to give quick and approximately correct answers to questions that most frequently arise in field work. Each diagram consists of three or more vertical scales. From a known point on one scale a line is carried to a known point on another scale, and where it cuts the remaining scales readings are made which are solutions to the problems. A celluloid index is provided for carrying the line.

Problems solved by these means include the determination of the safe load to be carried by piles, knowing the penetration under the last blow of the hammer of known weight dropping a known distance, the determination of the depth of the keystone for brick and cut stone arches, for various spans and rises, also the horizontal thrust for each 1000 pound pound load and the ratio of rise to span: the sag and the strain in copper and aluminum wire for various spans and the temperatures, the actual amperes transmitted at various power factors for single-phase and three-phase electric current, knowing the voltage and either the kw. or h.p. transmitted, the determination of the impedance and volt drop per mile of single-phase and three-phase current for different sized wires with different interspacial distances; earth canal data based on Tuton's formula; power developed by water or necessary for pumping; steel and wood stove-pipe specifications for various diameters and pressures and the flow of water in pipes canals and flumes for all values of n. Additional diagrams dealing with reinforced concrete reactance, capacity and regulation of transmission lines, economical sizes of pipe lines, friction losses in small pipes, strength of gears, driving power of shafts, belts, etc., are in preparation.

The procedure in each of these cases is reversible so that it is possible to find specifications to meet given conditions or find the conditions over existing lines. Incidentally they give a graphic idea of the effect of changing conditions. This note-book should prove an invaluable pocket companion and time saver to the engineer.

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
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Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

CORRECTION.—Line 26 in the article on "Co-operation" in the issue of February 26th should read "this does not mean combination."

OMISSION.—The articles on "Fuel Oil Burning," by R. F. Chevalier, which were scheduled for publication in this issue, have been delayed owing to Mr. Chevalier's illness. It is hoped that this valued series can be commenced with the issue of March 19th.

Electric Meters

To the great uninitiated an electric meter is a diabolical mechanism, a sort of a perpetual motion machine that mysteriously measures electricity. The average man or woman regards a meter much as a child does a watch when he wants to know "what makes the wheels go round." As a matter of fact, an electric meter is as simple as an electric motor whose revolutions are counted by a cyclometer. Current passing through the meter causes an aluminum disc to revolve. The more current, the faster the disc revolves; the less, the slower. The revolutions of the disc are transmitted by gears to the hands of the registering dials.

There are usually four of these dials placed in the same order as are the numbers in a column of figures arranged for addition. The right hand dial records units, the next tens, the next hundreds and the next thousands of kilowatt-hours, the kilo (1000) watt-hour being the basis of electric measurement just as dollars are the basis of our monetary system. A twenty-five watt tungsten lamp giving 20 candlepower lighted for forty hours consumes one kilowatt-hour, as do likewise forty similar lamps burning for one hour. The record is cumulative, one months' reading being subtracted from that of the previous month to ascertain the quantity used. This quantity multiplied by the unit price gives the bill.

Many electric light and power companies give their consumers instructions for reading their meters and thus encourage checking of bills. This policy creates confidence and engenders a sentiment of good will. It is probable that this friendly feeling would be further enhanced if a glass-case meter connected with a number of lights were placed in the company's office so as to be of easy access to bill payers. The cash register and the visible weighing scale are important factors in retail business because they remove distrust from the customer's mind. Frankness disarms the suspicion that attends the unknown.

It is well also that the collectors and meter readers be familiar with some of the facts that are being told in the series of articles regarding the watt-hour meter now appearing in these columns. A moment's explanation may save much groundless dissatisfaction among customers. We realize the danger that attends too intimate an understanding of meter construction by the unscrupulous, and furthermore we appreciate that "where ignorance is bliss, 'tis follow to be wise"; nevertheless, we have enough confidence in human nature to believe that the more a consumer knows about the instrument that measures his current the better satisfied he is.

PERSONALS.

Sidney Sprout of San Francisco, is in Oregon on an electrical engineering investigation.

A. C. Sprout, of Hall, Demarest & Co., engineers, is making a business trip to Keeler, Cal.

F. G. Decker has been appointed acting manager of the San Francisco office of the Platt Iron Works.

Leon M. Hall, consulting engineer for the Comstock mines, is visiting Virginia City on professional business.

M. C. Miller, assistant to the president of the Allis-Chalmers Company, of Milwaukee, Wis., is in San Francisco.

C. E. Gilman, of Duryea, Haehl & Gilman, engineers, will be manager of the Bay Cities Water Company of Oakland, Cal.

W. H. Schott, of W. H. Schott & Co., electrical engineers, of Chicago, who has been touring the Coast, is a guest at the Palace in San Francisco.

Bernard Corrigan, who has been president of the street railway system in Kansas City, has been touring California and is now a San Francisco visitor.

B. M. Downs, general manager of the Brookfield Glass Company, of New York, who has been making a business tour of the coast, returned from Seattle during the past week and left for Los Angeles March 2d.

C. S. Hancox, electrical engineer for the Queensland Government, Australia, left for the East last week after spending ten days in inspecting electrical installations in San Francisco. He expressed himself as much pleased with some of the new things he saw.

C. E. Groesbeck of San Diego and W. D. Riddell of Tacoma, who are interested in lighting plants in their respective cities, recently accompanied R. S. Chapman to Eureka, where an option was secured on the Humboldt Gas & Electric Co.'s holdings. A hydro-electric plant on the Trinity river is operated by the company and a steam plant in Eureka.

R. S. Chapman, representing H. M. Byllesby & Co. of Chicago, who have been extensively engaged in buying up gas and electric lighting properties throughout the Pacific Coast, has returned from a northern trip. Options have been taken on the plants of the Klamath Falls Light & Water Company and Moore Bros. Electric Company at Klamath Falls, Ore.

D. C. Henry, consulting engineer, Beck Building, Portland, Oregon, announces that the Secretary of the Interior has approved his request to be placed on a per diem basis as consulting engineer with the service instead of an annual basis as heretofore. This change will enable him to engage in private practice without severing connection with the service. Mr. Henry has been consulting engineer with the service for one year prior to which he was supervising engineer for the Pacific Coast District, embracing Washington, Oregon, Northern California and Nevada, in which states a large amount of work was done under his supervision, aggregating approximately ten million dollars, including numerous dams for irrigation storage reservoirs and diversion.

TRADE NOTES.

The Portland, Oregon, offices of the General Electric Company have been moved to the Electric Building at Seventh and Alder streets.

Hunt, Mirk & Co., of San Francisco, Pacific Coast agents for the Westinghouse Machine Company, have sold the largest Westinghouse-Parsons turbo-generator in this country to the Southern California Edison Company. It will be installed in a new power station, which is to be erected at one of the ocean beaches contiguous to Los Angeles. The contract calls for a 12,500 kw. machine with 75 per cent overload capacity. Contracts for auxiliaries and boilers are still pending.

W. S. Heger has accepted the management of the San Francisco office of the Allis-Chalmers Company, in addition to his present duties as manager of the company's Los Angeles office, succeeding R. B. Elder who has resigned as acting manager of the San Francisco office.

Mr. Heger has been actively associated with the sale of electrical and power apparatus on the Pacific Coast for more than twenty years. In 1889 he opened the San Francisco offices of the Edison Company for Isolated Lighting which was finally merged in the General Electric Company. For ten years following 1895 he was Pacific Coast manager of the Westinghouse Electric & Manufacturing Company, having established their offices here. In 1905 he resigned to become assistant to the president of the Allis-Chalmers Company, but in 1909 his many friends again welcomed him to the Coast when he assumed charge of the Los Angeles office of the company.

THE ELECTRIC STORAGE BATTERY COMPANY.

Announcement is made by the Electric Storage Battery Company of Philadelphia, Pa., that they have discontinued their San Francisco office, and, taking effect March 1, 1910, have appointed Pierson, Roeding & Co. as their sole Pacific Coast Selling Agents. Mr. George R. Murphy, a member of the corporation of Pierson, Roeding & Co., will be in charge of the new department, his long experience as the Pacific Coast engineer with the Electric Storage Battery Company particularly fitting him to handle both the technical and commercial branches of their varied interests.

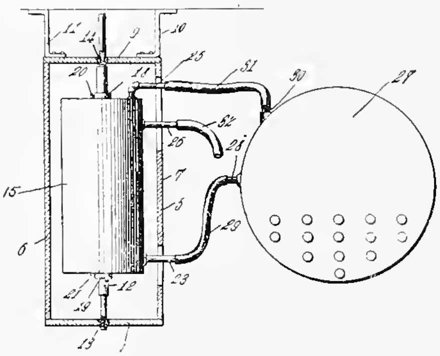
Recent advances in secondary distribution and the tremendous strides in the electric automobile have greatly enlarged the scope of the battery company, and they will now have the benefit of a selling and engineering organization, with branch offices in Seattle and Los Angeles, that will enable them to care for their product with a maximum efficiency.

Pierson, Roeding & Co. will not only handle the well-known "Chloride Accumulator," but will have under their control a well-equipped depot for the supply of the "Exide Battery," with its various parts, from a large stock carried in San Francisco. The new agents will temporarily carry on the business of this department at the former office of the Electric Storage Battery Company in the Crocker Building, San Francisco, and at the office of the Exide Battery Depots, Inc., 590 Howard street. It is planned to eventually consolidate all departments in new and commodious quarters. Pierson, Roeding & Co. are to be congratulated upon adding to the field of their activities another large Eastern manufacturing company whose product is of such importance to the electrical interests of the Coast.

The San Francisco office of the Allis-Chalmers Co., has closed a contract with the Nevada-California Electric Power Company for the first generator for a new power house on their Bishop creek development in California.

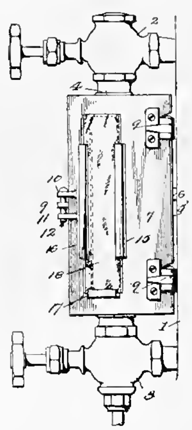
PATENTS

949,896.. **Feed-Water Regulator.** Arthur R. Herlache, Brussels, Wis. In a feed water regulator, the combination with a boiler; of a supporting frame arranged exteriorly of the boiler, a vertically disposed shaft having its opposite ends secured in the opposite ends of said frame, a cylinder adjustably secured to said shaft, said cylinder having a water-inlet at one end, a steam inlet at the other end and flexible



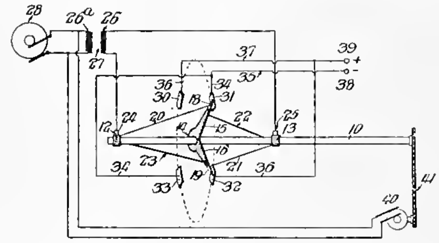
connections between the boiler and said steam and water inlets, said cylinder being further provided with a steam outlet arranged adjacent the said steam inlet, and a piston within the cylinder and slidingly fitted on said shaft and operable by the pressure of water and steam in the boiler to open and close communication between said steam inlet and outlet.

949,800. **Water-Glass Shield.** Hugh Montgomery and Frank G. Drolet, Milo Junction, Me. In a water-gage-glass protector, the combination with a boiler head, a water-gage-glass, water-gage connections arranged upon said boiler head



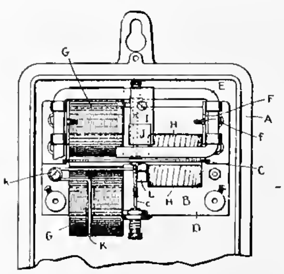
for supporting said water-gage-glass, of a back plate detachably secured to said boiler head, sides swingingly mounted upon said back plate and arranged to engage each other and form a triangular casing inclosing said water-gage-glass, a sight opening in each of said sides, and transparent material covering the same.

950,124. **High-Potential-Alternating-Current Rectifier.** Chester H. Thordarson, Chicago, Ill. A high potential alternating current rectifying apparatus comprising a plurality of rotative angularly separated, elongated, relatively light, thin arms made of non-conducting material and provided with means for bracing them from flexure out of the plane of rotation thereof and revolving at a speed in synchronism with the frequency of the alternating current to be rectified, commutator members located at the outer ends of said arms and connected with a source supplying alternating current, and a plurality of angularly separated collector plates arranged on the circumference of a circle described by said commutator



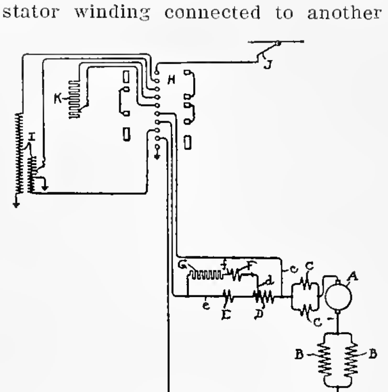
members with which the said commutator members are adapted for wiping contact, said collector plates collecting from the commutator members opposite polarities of an unidirectional current.

950,079. **Electric Meter.** Gustave A. Scheeffer, Fort Wayne, Ind., assignor to General Electric Company. In an electric meter, a rectangular core of magnetic material having an air-gap cutting one of the shorter sides of the rectangle and poles projecting toward each other from points near the



centers of the longer sides of the rectangle, a shunt winding surrounding the core and so positioned that the shortest magnetic circuit therefor is through that portion of the rectangle having a closed magnetic circuit and through the projecting poles, and a disk armature projecting between said projecting poles.

949,992. **Commutator-Motor.** Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company. A motor of the commutator type, adapted for operation on both direct and alternating-current, having a portion of its stator winding connected to another portion of



said winding and forming with said other portion and the connections between them a local closed circuit, and connections for including said portions in the main motor circuit for direct-current operation and excluding them therefrom for alternating-current operation.

INDUSTRIAL

A NEW PREPAYMENT METER.

To many householders the "pay-as-you-go" method of meeting expenses is much preferable to the monthly bill system, with its attendant bother. To persons of limited means, monthly payments are often a hardship. Each of these classes offers a broad field for the sale of electric current, and to enable the central station to make a more effective campaign for this business, new prepayment attachments for use with either direct or alternating current Thomson watt-hour meters have recently been perfected by the General Electric Company. Aside from the advantages as stated above, prepayment meters often act as a safeguard of the supply company's interests, for this device is an absolute protection against loss from unpaid bills and saves the expense of keeping a consumer's account, sending bills, and the several steps which must be taken before payments can be collected from some consumers.

This prepayment device is suppled either in combination with, or separate from the meter. Arrangements similar to those shown in the illustrations are made for direct current meters. The advantages of a separate attachment for some cases will be apparent, for although it is not always desirable to place the wattmeter proper in a location convenient to the consumer, the prepayment attachment can be installed wherever most desirable. The principle of operation is identical in either case except that the connection between meter and attachment is mechanical in the case of the combination and electrical in the other instance. The attachment consists of four principal parts, the escapement train, coin device, switch and rate device.

Fig. 1.

Thomson High Torque Watt-Hour Meter with Combined Prepayment Device — Type IP 3 — for Alternating Current.

When it is desired to make an advance payment the winding knob is turned so that the arrow points upward. A quarter dollar is then inserted in the slot and the knob turned to the right, the coin serving as a key which operates the mechanism within the device, turning the registering wheel and placing the coin to the credit of the consumer. If the circuit is open when the coin is deposited, the same motion of the knob which moves the registering mechanism closes the circuit switch contained within the case of the attachment.

The dial of the combined prepayment meter is enlarged and contains in addition to the standard marking, a scale marked in plain figures over which a pointer passes indicating the number of coins remaining to the credit of the depositor. When the meter has a separate prepayment attachment, the dial showing the number of coins standing to the customer's credit, is placed on the attachment.

When the first coin is deposited and the knob is turned, closing the main switch, the pointer rests opposite the first division on the scale. If a second coin is deposited before the current purchased with the first coin has been consumed, a second motion of the knob will bring the pointer opposite the second division on the scale. Twelve coins can thus be deposited consecutively, after which the slot is automatically closed and further prepayment cannot be made until the value of one or more coins has been consumed.

Whenever energy to the value of one coin has been delivered through the meter, the escapement is released (mechanically in the combined device, and electrically in the separate device) turning the pointer back one division. This process continues until all the energy for which prepayment has been made has been delivered. Thus the depositor can ascertain at any time how much energy can be obtained without further prepayment.

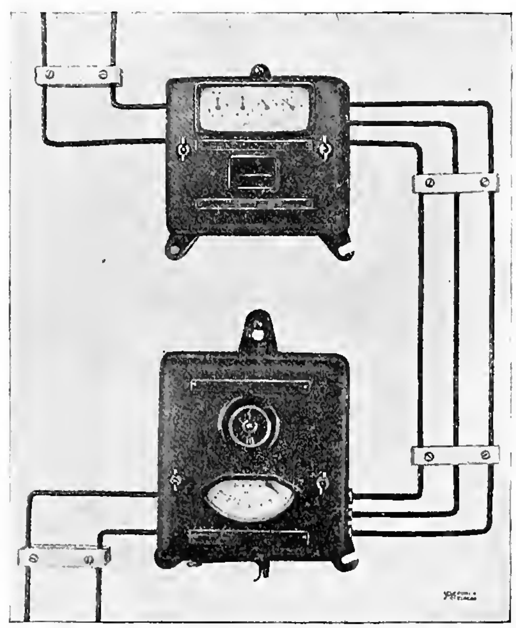


Fig. 2.

Thomson High Torque Watt-Hour Meter with Separate Prepayment Device—Type IP—for Alternating Current.

When all the energy has been delivered, the circuit switch is opened and no more current can be obtained until further prepayment has been made.

The indicating mechanism shows only the number of coins which stand to the credit of the customer; but by consulting the meter dial one can determine what fractional part remains of the prepayment next to be cancelled.

The actuating force which operates the device is a large flat coil spring enclosed in a barrel or drum to which its outside end is attached. The operating knob winds this main spring by turning the drum. The spring has many turns and as the operation of the device never equals one whole turn, the spring always exerts a practically constant force.

The rate device consists of a small train of gears secured to the front of the frame directly back of the register, the gear ratio depending upon the price charged for the service.

Each device is marked with the price per kilowatt-hour for which it should be used. It will be noted that this device is a separate member secured independently to the meter frame so that it can be easily removed and replaced by the electric lighting company in case the rate of charge is changed. The meter can be adapted to any rate of charge from 5 to 20 cents per kilowatt-hour in steps of ½ cent.

The switch is of the double pole, double break type with leaf contacts, the construction being similar to that used in heavy current circuit breakers. The toggle joint used to close the switch arms against the terminal blocks makes it impossible for the switch to open through accidental jar and also prevents any back pressure from being transmitted to the escapement train in such a way as to retard its action. The switch is liberally rated and will without injury to itself open any circuit carrying current up to the maximum overload allowable for the largest meter with which the device can be used.

The standard prepayment device is designed for use with quarter dollars. The coin receptacles are placed at the back of the meters so that the covers may be removed without interfering with the receptacle in any way. This feature permits the meter to be tested without affording access to the coin box, besides the collector, who is usually unfamiliar with the electrical features of the meter, cannot inadvertently injure its adjustment. The coins fall into a drawer which is removable from the bottom of the case and which can be secured by either a seal or any suitable padlock. The slot in which the coin is inserted is situated at the top of the meter case near the back.

Every precaution has been taken to guard against beating. A coin or washer larger than the coin for which the device is designed cannot be introduced into the receiving slot and a smaller one will not operate the device. The knob, once started with the coin locked in, cannot be reversed, but must be given a half turn to release the coin, which falls through a tube to the money box below. The coin is locked in as soon as the knob is moved and cannot be abstracted except by unlocking the money box. It is only by turning the knob that the consumer can obtain credit for his payment. A coin having a thread or wire attached will operate the mechanism, but the motion of the actuating handle prevents the withdrawal of the coin, which generally passes into the receiving box. Should bits of string prevent the coin from passing to the drawer, the intended fraud will be readily detected.

A MODERN ELECTRICALLY EQUIPPED ICE CREAM FACTORY.

An example of the modern ice cream factory employing the latest methods of production is that of E. A. Caum at Altoona, Pa. This plant has a capacity for making and storing 3000 gallons of ice cream daily, besides producing ten tons of ice and the equivalent of 30 tons of refrigeration. This latter brine refrigerating system is used to reduce the temperature in two ice storage rooms, two milk and cream rooms, two hardening rooms, and the retail sales cabinets, besides removing heat from the ice making apparatus and the ice cream mixing and freezing machines.

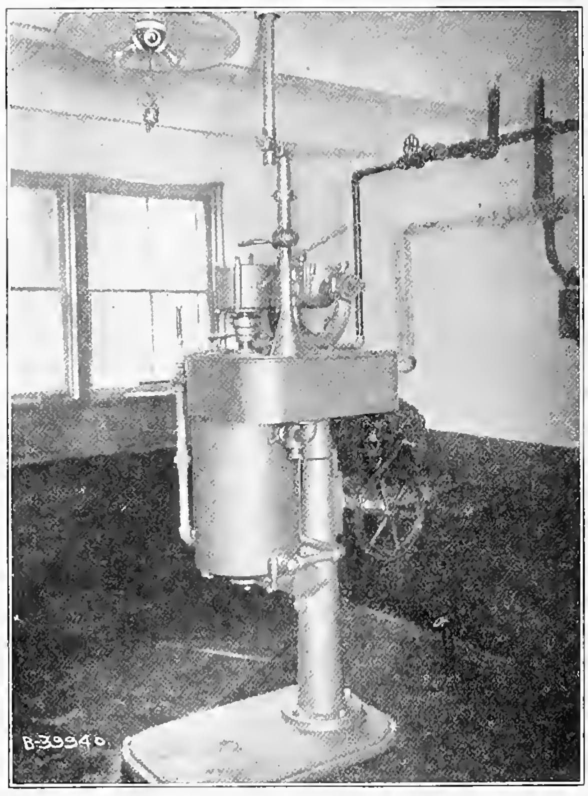
The brine in the refrigerating system is cooled by the expansion of ammonia gas, previously liquified by a 30-ton Larsen-Baker compressor. This compressor is driven through a Morse chain transmission by a 50 h. p. 200 volt, 60 cycle, two-phase type "CCL" Westinghouse induction motor. The brine is circulated by a five-inch Aldrich triple brine pump driven by a 5 h. p. Westinghouse type "CCL" motor.

In the ice cream making department, two Miller Duplex ice cream mixers, having a capacity of 150 gallons each, are installed. These are connected by German silver pipes to the refrigerating system, and are driven by two horsepower Westinghouse type "CCL" motors.

Directly underneath the mixing room is the freezing department where are located two Miller upright cream freezers, each of 60 gallons capacity per hour, and similarly chain driven by Westinghouse motors. In these machines connection to the refrigerating system takes the place of ice for the freezing operation. After being partly frozen in these machines, the cream is run out into the delivery cans of various sizes and transferred to the cooling rooms where it remains until sold.

Before refrigeration was installed, the common practice was followed by putting the ice cream as frozen into a big tub, from which it was measured into the cans and packed for shipment. This required packing the cream twice daily, and the ice hills alone at that time amounted to $15 or $20 a day,. a figure which contrasts greatly with the present total cost of running the plant since refrigeraion has been operated.

A Creasy ice crusher and pasteurizing machine and butter churn and worker are also installed in the Caum factory, being driven by 3 h. p. Westinghouse type "CCL" motor. Two 16-inch Hill deep well pumps, each capable of delivering 50 gallons of water per minute, are driven by 5 h. p. Westinghouse "CCL" motors.



Motor Driven Ice Cream Freezer.

The power supplied to the plant is two-phase, 60 cycle alternating current at 200 volts. All the motors are controlled from a starting panel which carries the auto-starter for the 50 h. p. motor, the simple starting switches for throwing the other machines across the line, the lighting snap switches, and the service watt-hour meter.

The present connected motor load aggregates 72 h. p., which is operated from two and one-half to three hours per day. For this service the power bill is about $55 monthly, which covers all the costs of pumping, refrigerating, freezing and churning. As noted before, the daily ice bill alone, before refrigeration was installed, amounted sometimes to $20 per day.

NEW TUNGSTEN FIXTURES.

Two new tungsten fixtures have recently been added to the Benjamin Electric Mfg. Co.'s list for store, shop and factory lighting. Besides being substantially constructed, both are inexpensive, and may be used with low-voltage street series lamps having small Edison base, thus taking advantage of this important recent factor in efficient incandescent lighting.

The fixture shown in Fig. 1 has cluster body with enameled steel reflector plate, 15-in. stem of ⅜-in. iron pipe and ¾-in. brass casing, 18-in. opal reflector, 5 in. x 4 in. canopy, and

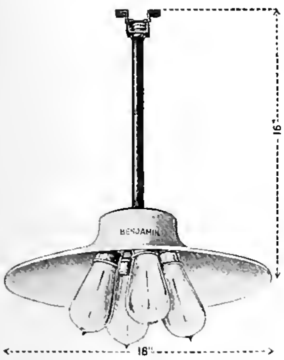


Fig. 1.

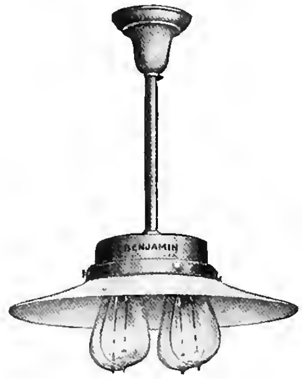


Fig. 2.

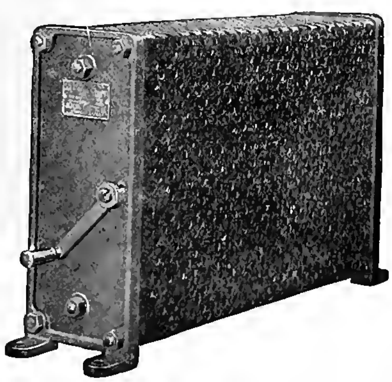
crowfoot, 2, 3 and 4-light fixtures will take 100-watt lamps. This fixture is neat in appearance and is especially adapted for stores and offices.

The fixture shown in Fig. 2 has a tungsten cluster, 18 in. deeply hooded enameled steel reflector, 12 in. stem ⅜ in. iron pipe, and shock absorber, 2, 3, and 4-light fixtures will take 100-watt lamps. Those contemplating factory, shop or warehouse installations will find them especially serviceable.

Both fixtures in question are made from 2 to 5 lights and as indicated may be furnished either in multiple or series.

BATTERY CHARGING RHEOSTATS.

In the rush and bustle of modern life many of the devices which contribute to our pleasure or assist us in business have features which may become a source of great annoyance, due to the difficulty of keeping them in a serviceable


Battery Charging Rheostat.

condition. This may lead to so much delay and inconvenience that the owner will gladly avail himself of any means of avoiding this unpleasant state of affairs.

The wide application of storage batteries as a source of power for electric automobiles, launches, etc., has made it imperative that means be provided for quickly charging them and that the apparatus be so simple that the charging may be done by anyone. The owner may then charge his own battery on his own premises.

Wherever a 125-volt direct-current circuit is available this may be easily accomplished without the use of expensive apparatus by the use of a General Electric CR 211 battery charging rheostat. It is simple in mechanical construction, of rugged design, and has a maximum current capacity amply sufficient to meet all conditions of service.

In order to prevent any possibility of accidental contact with live parts, the rheostat is thoroughly insulated and entirely enclosed by a cover so constructed as to permit of thorough ventilation.

These rheostats are very compact, present a very neat appearance and may be installed in any place. All parts are readily accessible for inspection and repairs.

Before closing the main switch to charge the battery, the handle should be moved as far from the supporting feet of the rheostat as possible. After the switch has been closed the handle may be moved toward the feet of the rheostat to regulate the current for charging.

MARINE ELECTRIC LIGHT FIXTURES.

The electrical appliances used on board ship must of necessity be constructed with special reference to the conditions under which they will have to be used. A source of light must be guarded from injury by a strong metallic guard capable of withstanding the impact of anything that may come in contact with it, such as freight that may be standing against it, or ropes. And it is equally important that it should be impregnable to moisture, as the electrolic action on current carrying parts is very rapid when such parts become wet with salt water.

Marine Fixtures and Guards.

Buxbaum & Cooley of Seattle manufacture a line of electric fixtures designed to meet the conditions of marine service. The accompanying illustration shows their No. 118 fixture with No. 63 guard. A test of several years' use has proved them to be able to meet all the conditions required

NEWS NOTES

INCORPORATIONS

ARCO, IDAHO.—The Arco Telephone Company has been incorporated for $1,500 by John W. Fowler et al.

TAMPICO, WASH.—The Tampico Telephone Company has been incorporated for $4,000 by Wm. O'Neal et al.

RUPERT, IDAHO.—The Rupert Electric Company of Rupert, with a capital stock of $10,000 has been incorporated by F. M. Victor and A. C. Brown.

PORT TOWNSEND, WASH.—The Key City Light & Power Company has been incorporated with a capital of $80,000 by John Siebenbaum et al.

SEATTLE, WASH.—The Glacier Development Company, capital $1,000,000 has been incorporated by B. Thomas and W. C. Berg, to supply electric power for heating, lighting, etc.

LOS ANGELES, CAL.—The Southern California Manufacturing Company has been organized with a capital of $50,000 by L. M. Ellis, manager of Union Home Telephone & Telegraph Corporation in the I. W. Hellman Building. The Company will have a plant at Long Beach, and manufacture telephone supplies.

SAN DIEGO, CAL.—The Lakeside Farmers' Mutual Water Company with a capital of $25,000 has been incorporated. The Directors are: G. J. Bach, F. L. Leber and O. E. Busenberg. The Company will deal in and improve real estate, construct ditches, reservoirs and other essentials for collecting and impounding of water upon its own property.

TRANSMISSION.

SAN DIEGO, CAL.—The Spreckels interest has leased the land on which the Akerman & Tufflen olive factory at Old Town now stands, to erect a power house.

TACOMA, WASH.—Wright, Sweeney & Cummings, Tacoma, submitted low bid, $655,225.50, for the construction of the tunnel for the municipal power plant on the Nisqually river.

UNDERWOOD, WASH.—Dement Bros. of Walla Walla who are to build the flouring mill here have secured a power site two miles up the White Salmon river where a dam 80 feet high will be constructed and a power plant installed.

SEATTLE, WASH.—The Pacific Coast Power Company has secured the right to divert 2000 ft. per second of the waters of White river to Lake Tapps for the development of 30,000 electric horsepower. The power house will be located on Stuck river.

FORT BAYARD, N. M.—Contracts for a central power plant and a hospital sergeants' quarters at Ft. Bayard have been let. J. A. Harlan was the lowest bidder on construction work of both power plant and hospital sergeants' quarters, his bid on power plant being $33,322 and on quarters $7250.

PORT ANGELES, CAL.—An ordinance has been presented granting a franchise to the Port Angeles Power and Electric Company for the distribution and sale of electric power, heat and light within the limits of the city, for a period of twenty-five years. The franchise stipulates that guarantees shall, within one month after acceptance, begin the construction of a hydroelectric power plant on Little river.

AUBURN, CAL.—A surveying party, headed by Adrian Wills, an Auburn surveyor, is now engaged in running lines and taking levels between Forest Hill and Auburn by direction of William Muir, the mining man, who contemplates bringing water from just below Forest Hill to Green Point, at the junction of the North and Middle Forks of the American River about three miles east of Auburn. It is stated that Muir will erect a power plant at Green Point to generate from 25,000 to 30,000 horsepower. The specifications call for two ditches, extending from near Forest Hill to Green Point, a distance of 20 miles. The two water ditches will meet at Green Point, where the proposed power plant will be, the fall being close to 600 feet.

SAN DIEGO, CAL.—The San Diego Electric Railway Company is planning to increase its generating facilities and has recently placed an order with Allis-Chalmers Company for a 28 and 60 by 48 vertical cross-compound condensing engine. This will be supplied with steam at 160-pound pressure and a vacuum of 26 inches will be maintained. The engine will operate at 80 r.p.m.

RED BLUFF, CAL.—Dr. J. M. West has filed a notice in the office of the County Recorder claiming 300,000 inches of water of the Sacramento river, to be taken out at the mouth of Red Bank creek, which is about three miles south of Red Bluff. The water is to be used in Tehama, Glenn, Colusa and Yolo counties for irrigation, generating electricity, domestic and other uses. The amount of water claimed would be practically all the water of the river and would be sufficient to irrigate many thousands of acres of land. Dr. West claims he is working in the interests of the Tehama County Power and Transportation Company, of which he is a director. This company was organized some years ago, and has filings on waters along Mill Creek for power purposes. He also states that Eastern capitalists are negotiating with his company with a view to taking over its holdings.

TRANSPORTATION.

VANCOUVER, B. C.—The B. C. Electric Railway will soon begin construction of its line on Broadway east from Scott street to Park drive.

WENATCHEE, WASH.—The Wenatchee Valley Railway & Power Company is asking a franchise in the city and proposes to extend its lines to Leavenworth and other towns if same is granted.

BUTTE, MONT.—An ordinance has been passed by the City Council for the building of an electric ore line by the Davis-Daly Company from the Colorado mine to the N. P. to connect with the Great Northern.

NORTH PASADENA, CAL.—Surveyors were at work on North Los Robles avenue preparing for a gang of workmen who are soon expected to start laying the extension of the Los Robles avenue car line to the city limits.

SAN JOSE, CAL.—One result of the recent consolidation of the First Street Railroad system with the Santa Clara Street system has been the elimination of the fare-books whereby 26 rides could be bought for $1. Hereafter the 5-cent fare will be collected.

LOS ANGELES, CAL.—City Attorney Hewitt has been authorized by the City Council to draft an ordinance providing for the construction by the Pacific Electric Railway Company of an overhead crossing on the Mission Road. The work will cost about $86,000.

LOS ANGELES, CAL.—Judge Bordwell has handed down a decision quieting the title of the Los Angeles Pacific Railway Company, to a 20-foot strip of right of way near Hollywood. The decision was granted against Carl Schultz, who asked $2000 damages in a cross complaint for alleged injury to the trees on his land.

PENDLETON, ORE.—Work is to be started on the Pendleton City & Interurban traction line in the near future. The Washington & Oregon Traction Company which is to build this system has agreed under bond to build six miles of road within the city within a year's time.

SACRAMENTO, CAL.—No time was lost by the Central Traction Company in resuming work on its road between this city and Stockton, after which temporary injunction which stopped work on the Upper Stockton road was dissolved. Four big construction gangs went to work between this city and the Cosumnes River.

LOS ANGELES, CAL.—It is expected that cars will run over the new Seventh street bridge about March 1st. This is on the Los Angeles railway company's system and the cars will run from the western extension of Washington and Seventh streets across the river to Boyle Heights and by way of Stephenson avenue and Downey road out into the eastern country.

COVINA, CAL.—The Covina electric line will continue east on Badillo street to a point two miles east of Covina, thence in a northeasterly direction to Covina avenue. It will enter the town of San Dimas where it will be joined by the extension from Glendora. From San Dimas the line will run direct to Claremont and join the Kerchoff line now being constructed from Pomona to Claremont.

SALT LAKE, UTAH—Contracts have been awarded by the board of public works for the laying of all water mains in the city during this year, and also for the construction of a concrete conduit in Parley's creek at Twelfth South street, for a distance of about 400 feet. P. J. Moran was awarded the contract for the water mains upon his bid of $49,438.60. The Moran Construction Company of Ogden was awarded the Twelfth South street contract on its bid of $5895.98.

FRESNO, CAL.—A conference of Fresno and Kings county bankers was held in this city this week to consider the endorsing of the $150,000 worth of bonds to be floated by the Fresno-Hanford Railroad Company. It is understood that if they are endorsed by the Fresno and Kings county bankers, a San Francisco capitalist stands ready to take them up immediately. In the contract drawn up between the Fresno-Hanford Railway Company and the Hudson Counties Improvement Company, one of the provisions was that the Hudson Counties Company would furnish $650,000 and build the proposed road if the local company furnished $150,000. The officers of the local company are now seeking to float bonds for this amount.

ILLUMINATION.

COLTON, CAL.—A contract has been awarded for the Central gas plant at Colton with 2,000,000 feet capacity which will cost $132,000.

NEWPORT BEACH, CAL.—The Trustees have accepted the bid of J. H. Adams & Co. for bonds recently voted by the city—$25,000 light and $40,000 water, bearing 5 per cent interest.

EVERETT, WASH.—An ordinance was introduced granting the Seattle-Tacoma Power Company, a franchise for light poles on First street, from the eastern city limits to Maple, thence two blocks on Maple to the river.

NEEDLES, CAL.—The Needles Light & Power people contemplate a number of improvements on their plant. Work will begin shortly on a concrete power house, about twice the size of the present one. An additional engine and generator will be added to the present equipment.

GRIDLEY, CAL.—An ordinance has been passed calling a special election to be held on March 5, 1910, at which time will be submitted the question of issuing and selling bonds in the amount of $17,500 for the acquisition, completion, extension and maintenance of an electric light and power plant and distributing system and certain franchise, contracts and equipment for the city of Gridley.

OROVILLE, CAL.—The report that this company intended to begin work upon the construction of its dam at Humbug Valley this summer is denied by the manager of the Oroville Water, Light & Power Company, R. Leo Van der Naillen, Mr. Van der Naillen states that while the company intends ultimately to establish a power plant there, there is nothing in contemplation for the immediate future.

LOS ANGELES, CAL.—The Southern California Edison Co. has applied to the Supervisors for a franchise to construct and erect and for a period of 40 years to maintain and operate, all piers, masts, poles, etc., upon or from which to suspend, affix and hang wires, cables or other appliances for transmitting electricity; also to lay, maintain and operate wires, cables, etc., to transmit electricity over, under and across certain county roads, highways, etc., within the county of Los Angeles, commencing at the north boundary of the City of Pomona.

TELEPHONE AND TELEGRAPH.

JACKSONVILLE, ORE.—E. C. Sharpe et al have been granted a franchise to install a telephone system, etc., here.

CHENEY, WASH.—The Washington Southern Telephone Company of Spokane has applied for a telephone franchise here.

ROSEVILLE, CAL.—Manager Bryson was authorized to build a telephone line from Alta to Rawhide along the present trail and country road.

POCATELLO, IDAHO.—The Bell Telephone Company is planning to extend its Hollister line to the Salmon river dam and from there to Jarbidge.

RITZVILLE, WASH.—The Washington Southern Telephone Company of Spokane has made application for a franchise to install a telephone system here.

SAN FRANCISCO, CAL.—The Western Union Telegraph Company, through its local officers, announces that hereafter it will receive and transmit messages telephoned to its offices.

SANDPOINT, IDAHO.—M. A. Phelps, general manager of the Interstate Telephone Company, announces that the company will extend its system so as to give a general long distance service both east and west.

MEDICAL LAKE, WASH.—B. F. Nail has been elected president of a telephone company which will run a line from there to Denny Bluffs and from there to Waukon to be known as the West Lake Telephone Company.

LOS ANGELES, CAL.—The Pacific Telephone and Telegraph Company has acquired from the Monrovia Home Telephone and Telegraph Company all of the business in a district including the cities of Monrovia, Duarte, Arcadia and Santa Anita, in the San Gabriel valley.

LOS ANGELES, CAL.—It is proposed that subscribers to either the Home or the Pacific Telephone and Telegraph companies in Los Angeles be enabled to obtain connection on the system to which they are not subscribers by the payment of five cents for each switch. This matter is to be taken up by the new board of public utilities.

SAN FRANCISCO, CAL.—It will require 21,000 telegraph poles, it is estimated, for the Postal Telegraph Company to build its new four wire line between Salt Lake and Reno the coming summer. The contract has been let in Michigan for the poles at a cost of $85,000. It will require 210 cars to freight them at a cost of $40,000. The work will need 2600

miles of copper wire, 350 pounds to the mile, a total of 910,000 pounds, or 455 tons to cost $136,500. This will give four more wires from Salt Lake to San Francisco.

REDLANDS, CAL.—The Directors and officers of the Southwestern Home Telephone Company were elected last week at a meeting held in the office of the company on Fourth street. The reports made by the officers were satisfactory to the stockholders. K. C. Wells, who has served as president of the company for the past several years, was again elected to that position by the directors. The list of officers and directors now stand as follows: President, K. C. Wells; vice-presidents, A. Gregory and Charles A. Rolfe; secretary and treasurer, J. J. Prendergast; other directors, Henry Fuller, W. F. Holt, J. F. Dostal.

WATERWORKS.

CENTRAL POINT, ORE.—A contract for the construction of the new water system has been awarded to the Jacobson-Bade Company of Portland, for $21,279.51.

BELLINGHAM, WASH.—The water board recommended to the City Council that the bid of Crane & Co., of Seattle, on a total of 20 tons of cast iron pipe be accepted. The bid was $34.50 per ton.

VALE, ORE.—Newbill & Coleman who were let a contract for boring a well to make a test for the city water, have reported going 29 feet and are now into a fine sand with any quantity of water.

ROSS, CAL.—Sealed bids will be received by the Board of Trustees for the furnishing and installation of six electrically driven centrifugal pumping plants with necessary equipment in the town of Ross.

SWANSEA, ARIZ.—The Clare Consolidated Gold and Copper Company at Swansea is preparing to install another pump and a 6-inch pipe line for conveying the water which is pumped from the river to Swansea.

EVERETT, WASH.—A pressure standpipe is to be erected by the Everett Railway, Light & Water Company to give service to the southwestern portion of the city too high to be taken care of by the reservoir.

LOS ANGELES, CAL.—At the earliest possible date a certificate of election will be filed with the Secretary of State and an ordinance calling for the harbor and power improvement bonds election may be passed upon by the Council.

COMARRON, N. M.—The Colfax County Commissioners have granted to H. H. Webster Jr. of Comarron, a franchise to construct a waterworks system to supply the town of Comarron with water for domestic and public purposes.

TACOMA, WASH.—Sealed proposals have been received by H. J. McGregor, commissioner of public works, for the construction of cast iron water mains on Adams street, Union avenue, South Seventh, Eighth, Ninth and Eleventh streets.

ASHLAND, ORE.—The fire and water committee has submitted reports recommending the laying of six-inch water mains for certain districts in the vicinity of Ashland street and boulevard and a four-inch pipe for the remainder of the territory.

HOOD RIVER, ORE.—The City Council has accepted bids on the municipal bond issue of $90,000 for a city water system and has awarded the handling of the securities to John Nuvoon & Co., bankers, of Chicago, who will pay a premium of $726 for the paper.

SILVER CITY, N. M.—The Silver City Water Company is sinking wells to the depth of 500 feet in locations where it is positive of securing a flow of water sufficient for all purposes, including new sewerage system which will be installed if the bond issue of $50,000 is voted.

MADERA, CAL.—Sealed bids are being received by the Board of Supervisors for the following: 400 feet black dip pipe, to have crosses every 15 feet; 1600 feet 2-inch pipe, galvanized; 100 feet 3-4 inch pipe, galvanized; 1 6-inch gate valve; 8 2-inch gate valves; 24 crosses, 6x6x2x2 inch; 100 T's 2x2x3x4 inch; 75 3-4 inch plugs; 16 2-inch plugs; 2 6-inch sleeves or couplings; 1 6-inch cap; 8 2-inch cap; 24 3-4 inch garden valves; 1 7x7x6 inch cast tee with hubs for calkings. ings.

SAN DIEGO, CAL.—An ordinance adopted by the City Council appropriates $1600 to cover the cost of constructing an eastern foundation for the steel tower tank which is to be erected on the property adjoining the Old University Heights reservoir for the purpose of giving a better water supply to that section of the city. The contract for constructing the foundation was awarded to W. G. E. Gabrielson for $1580. Other bidders were: Knight & Hyde, $2350; Clark & Goodbody, $1900; Olaf Nelson, $1710.

MEDFORD, ORE.—The City Council has passed resolutions providing for a six-inch water main on Jackson street from the end of the present main to Vermont street; a four-inch main on Thirteenth street from Newton street to Peach street; a four-inch main on Fourteenth street from Newton to Peach street; four-inch main on North Oak street, in Gray's Addition from Jackson street north to the end of North Oak street, and a four-inch main on Almond street from East Main street south, to the end of Almond street.

PASADENA, CAL.—The first step of importance in the merging of the three water companies of Pasadena into one public service corporation in an attempt to solve several dry tract problems of the city, was taken today, when the West Side Land and Water Company, the only one of the three in debt, issued an assessment levy of $2 per share on all stock. As a public service corporation, the merged company will be forced to furnish water to all parts of the city regardless of the stock issued by individual companies during their existence as mutual companies.

SAN FRANCISCO, CAL.—After several months of effort to effect a merger with the People's Water Company of Oakland, the Bay Cities Water Company, controlled by the Tevis interests, announces that all negotiations with the People's company are off and that it proposes to come into the market and sell water to the trans-bay municipalities in bulk. Up to last Wednesday there was a strong possibility that the merger scheme would be carried out, but the point was reached where neither side would give in and all negotiations were declared off. The People's company look upon the announcement of Mr. Tevis as largely bluff, on the grounds that he will not be able to deliver water to Oakland or Alameda, owing to the probability of law suits over his alleged water rights in Santa Clara County.

JACKSON, CAL.—An important suit has been commenced in the Superior Court at San Andreas, Calaveras county, by the California Storage Water Company vs. Ernest Krentz and 65 others, named as defendants, with some 40 John Does. The suit is with the object of condemning lands on the Calaveras river for the purpose of storing the floodwaters thereof, thereby generating electricity and supplying the towns of Valley Springs, Burson, Wallace, Jenny Lind and Milton, in Calaveras County, and Bellota, Linden, Lodi, Woodbridge, Peters, Farmington, Ripon, French Camp, Lathrop and Atlanta, in San Joaquin, with water for domestic purposes, besides irrigating an immense tract of new country. The location of the proposed dam is at a point six miles below Petersburg, where the country is low. The dam will be 175 feet in height and 1000 feet long, and built across the river bed. It has been estimated that such a dam would impound 20,000,00[illegible] cubic feet of water, holding the floodwaters of the Cal[illegible] ver.

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POWER AND GAS

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JOURNAL OF ELECTRICITY
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VOLUME XXIV SAN FRANCISCO, MARCH 12, 1910. NUMBER 11

STORAGE SYSTEM OF SOUTH YUBA WATER COMPANY

BY H. M. COOPER [1]

The denudation of the forests of California since its settlement in 1849, more particularly in the middle central section of the state, has made the conservation of water a difficult problem. The United States government, realizing the necessity for the preservation of the forests, primarily for water conservation, has, within the last decade, established stringent regulations, and has, at certain vital points of the state, established forest reserves for the purpose of protecting the remaining trees, and aiding thereby the protection of the watersheds, that, in future years, will be invaluable to the industries of the Pacific slope. Within the northeasterly regions of the South Yuba system little or no timber ever grew, the granite walls of the Sierra Nevadas affording little foothold for foliage.

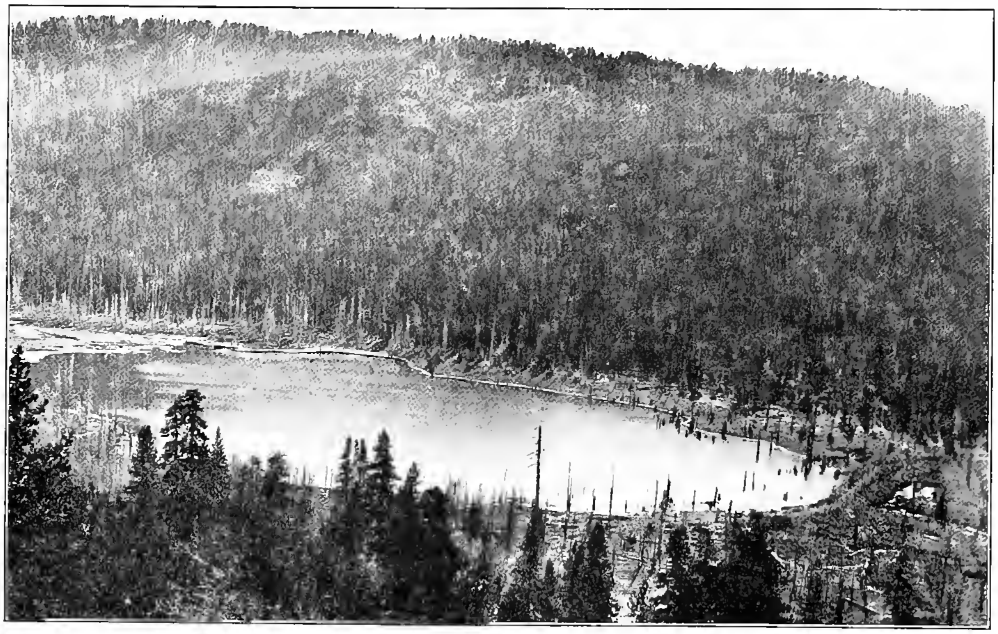
Lake Alta, in Placer County.

The high altitudes precipitate large quantities of snow during the winter season and the run-offs from the watersheds controlled by the South Yuba Water Company, following the average winter, more than provide for the needs of the company in its supply of water for mining, irrigation and domestic purposes. The watersheds, particularly of Lake Fordyce, Lake Spaulding, Meadow Lake, and the chain of lakes known as Felley, Culberton, etc., would provide, with additional storage, more than sufficient water to supply not only the needs of the South Yuba water system as at present developed, but also the entire Sacramento and San Joaquin valleys with water for municipal purposes, and there would then be a sufficient quantity left to supply the entire city and county of San Francisco.

Many opportunities are presented for the utilization of the waters stored at the higher altitudes for the generation of electric power, particularly in the canyons of the Yuba river, and on the South Fork and Middle Fork are splendid reservoir sites as yet undeveloped. The dams at Lake Fordyce and Lake Spaulding could be materially increased in height to afford additional storage.

The following is a brief description of the present storage capacities possessed by the South Yuba Water Company generally, giving the character of dam,

[1] Superintendent Pacific Gas and Electric Company's Auburn Water District.



Lakes of Lake Valley.

structures, and capacities of present available water.

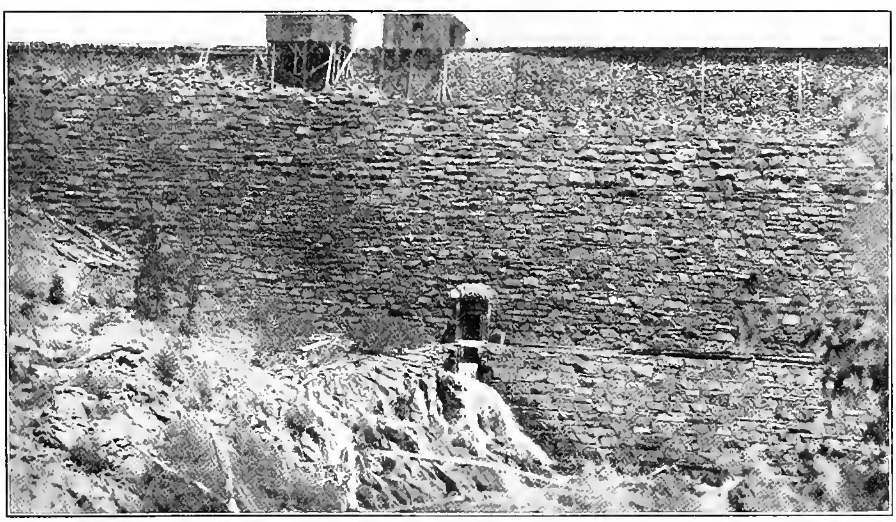
Few people aside from those directly interested realize the importance of an efficient water storage, and the great cost and many details necessary to conserve a part of the winter floods for use during the the dry or irrigating season.

The South Yuba Water Company diverts, from storage alone, into the canals about 1,000,000 miner's inches; this is the amount of water in reserve and is not drawn upon until all the overflow of surplus water has been consumed. Last season's storage was drawn upon July 20th, and with reasonable care on the part of consumers the amount was sufficient to keep up the supply during the dry season.

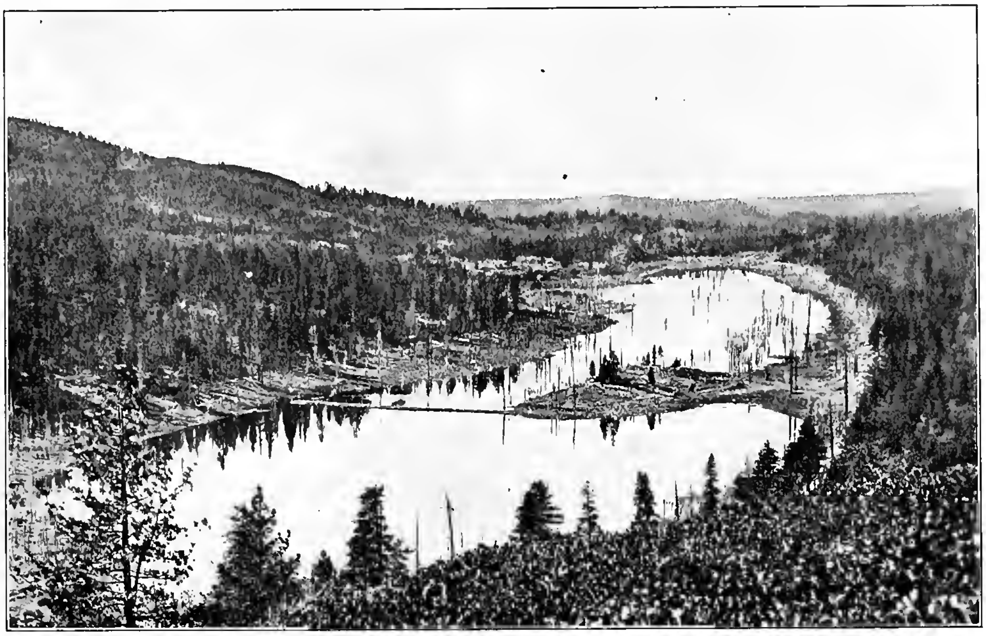
As early as 1850, ditches were constructed to supply water for miners using "long Toms," although it was not long before the system of hydraulic mining was introduced, necessitating more ditches and an increased water supply; later all hydraulic mining was enjoined, which decreased the demand for water to such a degree that improvements in the system came to a standstill. Within a few years the consumption began to increase, due to the rapid strides in electricity requiring hydroelectric generating stations, and the development of deep-mining using water to operate pumping plants, hoists, etc., and the planting of extensive orchards which depend entirely on storage water for irrigation, until today the water requirements are much greater than ever before.

To meet the almost continuous growing demands, a series of lakes has been constructed for storage purposes. At present this system comprises 23 lakes and reservoirs, which have a combined holding capacity of 48,700 acre feet, or 1,227,000 miner's inches, equivalent to 2,122,022,000 cubic feet, or 15,915,165,000 gallons.

These figures represent the total amount of stored water. Absorption, which is the combined action of evaporation and percolation, represents the loss of a large amount of water. However, the loss from deep lakes is much less than from shallow ones having the same surface area, where climate and altitude are identical. The evaporation is least when the air is quiet, the temperature of water low, and the atmosphere moist. When brisk winds are blowing which disturb the water surface, on a hot day, the evaporation is greatest, as the unsaturated air readily absorbs the vapors arising from the disturbed water. Naturally, the deeper the lake the less water is exposed to the sun. The whole mass of water is held at a lower temperature than otherwise. The cool water tends to condense the moisture from the warm air, which is a gain rather than a loss as many would suppose. In a shallow lake, with the temperature of the water higher, the evaporation is greater; therefore, when conditions permit, it is desirable to draw off the small



Downstream Face of Fordyce Dam.



Holding 1,725,300,000 Gallons.

and shallow lakes during the early part of the season, thereby preventing a considerable loss due to evaporation. The deep water lakes are held intact until the latter end of the season.

The largest and most important storage in the South Yuba system is Lake Fordyce, lying in portions of sections 25, 26, 34, 35 and 36, T. 18 N., R. 13 E., with a small part in section 3, T 17 N., R. 13 E., and covering altogether a flooded area of 510 acres, with a capacity sufficient to furnish a flow of about 400,000 miner's inches in twenty-four hours. The dam was built in 1871 and 1872, and it is composed of solid masonry, 75 feet high and 645 feet long. It has a catchment area of 30.15 square miles, a maximum capacity of 875,000,000 cubic feet, which is equivalent to 20,090 acre-feet, or a flow of 404,166 miner's inches in 24 hours. The elevation at the crest of the dam is 6,294 feet; at the bottom outlet, 6,225 feet.

The dam is of earth and rock fill, faced with 3-inch by 8-inch plank on the inner side, and has a maximum height of 92 feet and a length of crest of 800 feet; the width of the crest is 5 feet; and the maximum width of the base is 139 feet; the inner slope is 1 to 1, and the other slope 1/2 to 1 and 1/4 to 1.

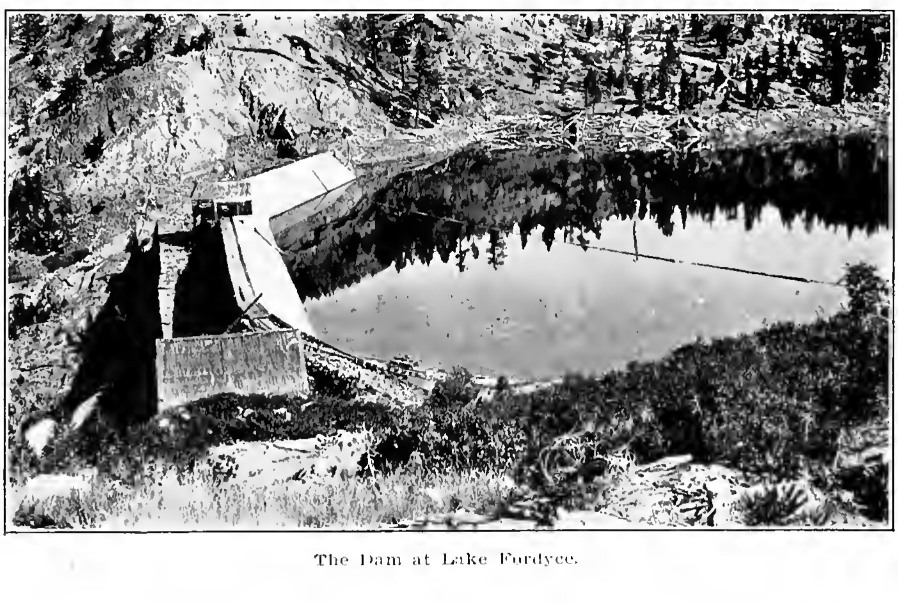
The spillway is 99 feet wide by 3 fee, 7 inches deep, with checking planks bringing high-water to the crest of the dam.

The outlet pipe is 36 inches in diameter, of 1/4 inch concrete. The flow is controlled by a slide gate of cast iron, 3 feet 6 inches by 5 feet 2 1/4 inches, placed at the upper end of the pipe, and operated from the crest of the dam by mechanism and by stem on the face of the dam. There is also a 30-inch gate-valve at the lower end of the outlet pipe.

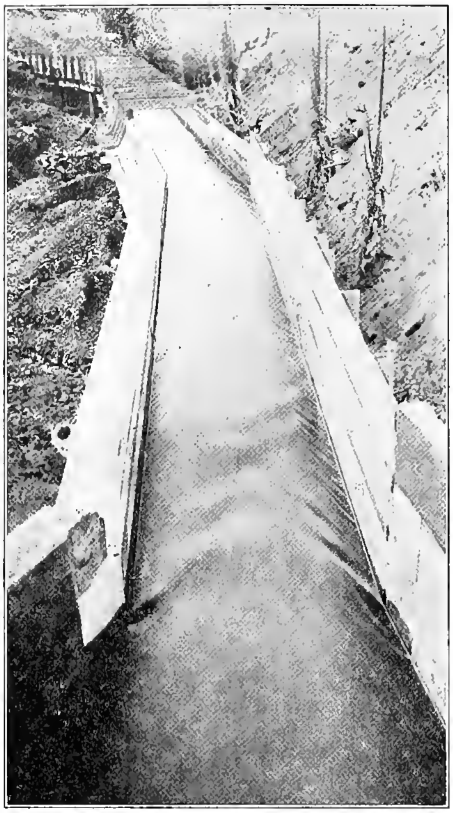
The work on Lake Fordyce was started by the South Yuba Water Company in 1875. During the years 1874 and 1875 a large force of men was employed, and the dam was completed to a height of 55 feet.

A masonry wall of two tiers of rock was built to form the down stream face. Then the body of the dam was built up of loose rock, hand placed. The inner slope of the dam was then formed by a layer of rock and earth, and was faced with boards. In 1881 another tier, 16 feet high and 5 feet wide at the crest, was added, bringing the dam to its present height. It is estimated that the run-off from Lake Fordyce is sufficient to fill the reservoir at least twice during the driest year.

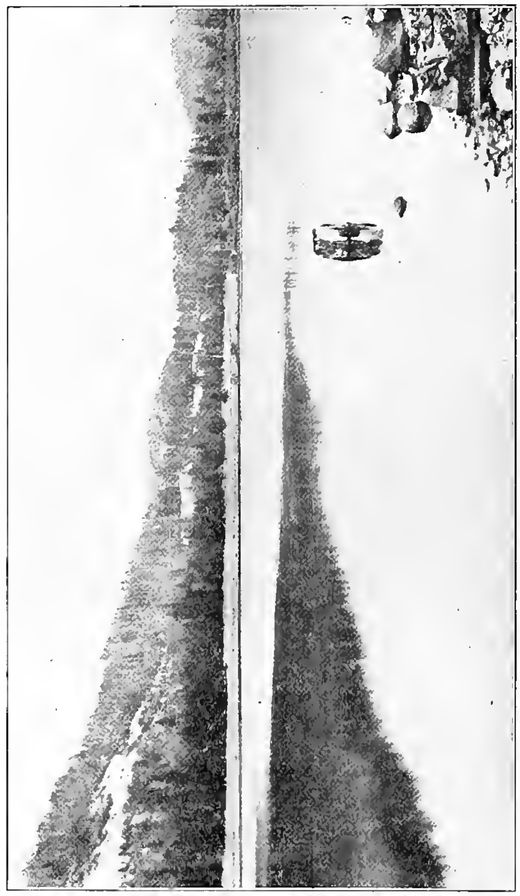
With the exception of Lake Valley, the whole of this water comes from the water-shed feeding the South Yuba river, and with the exception of Bear Valley Lake and Lake Valley, the storage water is controlled by Lake Spaulding, where it is drawn from the outlet gate into the river to be again diverted to the main canal leading to the lower country. At Bear Valley a certain portion of the water is turned



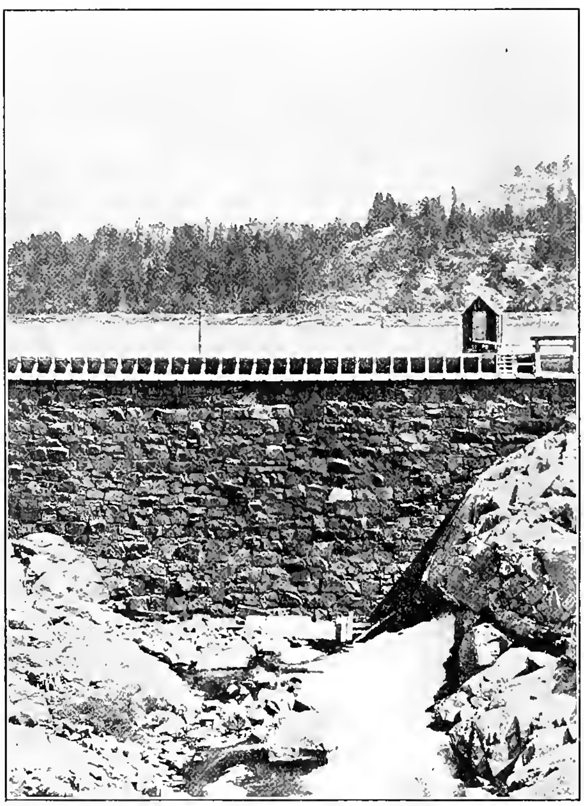
The Dam at Lake Fordyce.



Water Leaving Alta Power House.



Bear Valley Lake.



Dam at Lake Spaulding.

out of the main canal into the lake, which is used for a combined storage and regulator, whence it is drawn into the Boardman ditch, which in turn connects with the Lake Valley water at the head of the Alta Power House pipe-line. After leaving the water wheels at the power house the water is again taken up, and it then flows as far west as Rockville, Placer county. The main canal, after leaving Bear Valley, continues its course as far west as Grass Valley, Nevada county.

The following list gives a detailed account of each lake:

Name of Lake.	Elevation at Crest of Dam.	Flow Capacity Miner's Ins.	Water Depth Ft.	Ins.
Sterling	6700	33,220	19	
Spaulding		117,600	51	
Lake Valley	5846	106,500	55	
White Rock	7752	13,500	9	
Meadow	7249	92,620	30	
Bear Valley	4365	6,500	24	
Van Norden	6770	106,500	25	4
Upper Peak		33,200	37	
Lower Peak		10,600	26	
Kid Peak		32,300	28	6
Lost River		5,000	7	
Blue		23,900	24	4
Rucker		9,600	15	
Fuller		19,400	27	
Upper and Lower Rock		26,000		
Upper Feeley		6,000	11	9
Upper Middle and Lower Lindsay.				
Culberson.				

THE ORCHARD-IRRIGATING SYSTEM OF THE SOUTH YUBA WATER COMPANY.

BY W. E. LININGER.[1]

The irrigation system of the South Yuba Water Company is largely the result of the passing of the mining industry.

The gradual working out of the placer mines about that time rendered it necessary for many people to seek other means of livelihood and, the cities on the Comstock lode and other mining towns in the state of Nevada affording good markets, a large number turned their attention to horticulture. The demand thus created for water soon became greater than the

Three Square Miles of Orchard Irrigated near Loomis.

An Irrigated Orange Orchard Upon Undulating Hills near Loomis.

In the early 50's the Bear River Ditch Company constructed a canal about 50 miles in length from a point on Bear river about three miles above Colfax to a point near Newcastle, and from that point constructed several smaller distributing ditches for the purpose of supplying water for mining purposes. The control of this company passed through several different stages before, in 1876, it was purchased by E. Birdsall.

Up to that time irrigating had not been considered a factor in the water business. A few of the people, however, irrigated small garden patches and a few

Flume and Pipes near Gold Run.

Section of South Yuba Canal.

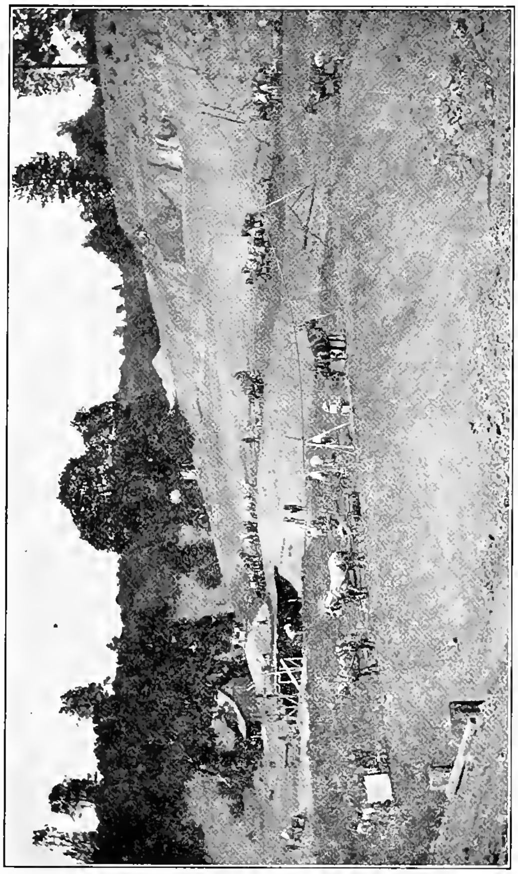
trees and vines, the product of which was marketed principally among the miners in adjacent towns.

Those pioneers in the fruit business demonstrated two facts: first, that the climate was ideal, and second, that with water for irrigation deciduous fruits could be grown to perfection and at a profit.

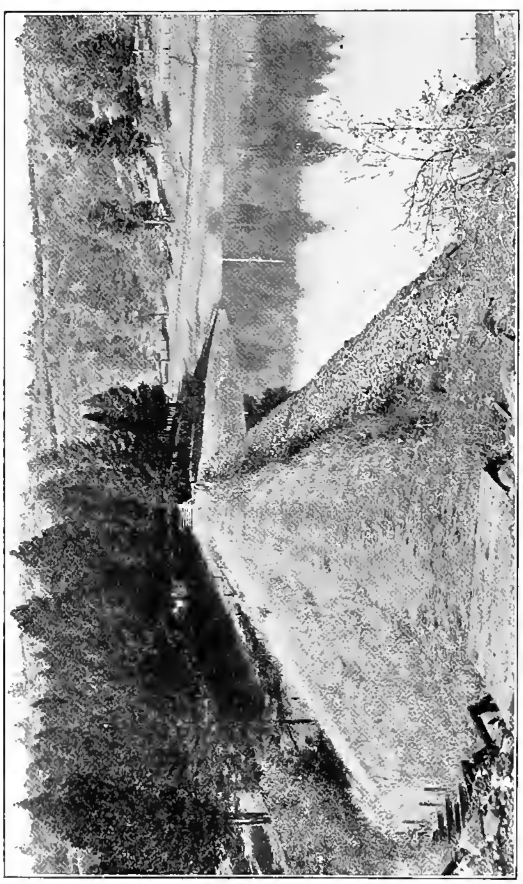
[1]Pacific Gas and Electric Company's Auburn Water District.

Birdsall company was able to supply during July, August, and September, as it had no storage and was entirely dependent upon the natural flow in Bear river, which was very low during these dry months.

The South Yuba Water Company, which up to that time had been operating only in Nevada county, and, prior to Judge Sawyer's decision in the debris cases, had derived a large part of its income from the sale of water to the hydraulic mines, had built or acquired a number of storage reservoirs. Among them were Lakes Fordyce, Meadow, Sterling, Cascade, and others, to provide an ample water supply during the whole of the year. The effect of the Sawyer decision, closing nearly all the hydraulic mines, left the South Yuba company with a bountiful supply of water for which there was no sale, and also cut off the greater part of the company's revenue. During the last few years of the Birdsall ownership of the Bear River ditch considerable quantities of water were therefore easily purchased by the Birdsall company from the South



Lake Arthur Dam During Construction.



Lake Theodore in the Summertime.

Yuba county during the later months of the dry season.

This state of affairs did not prove satisfactory, and in the year 1890 the South Yuba company bought the Bear River ditch properties and began a systematic development of the irrigating system.

The constantly increasing demand for water, necessitating an increase in ditch capacity and storage, resulted in the reconstruction of the Boardman ditch from Bear Valley to Gold Run; thence in the building of a new system into the fruit district, a distance, by way of the ditch, of 16 miles; also in the building of Lake Spaulding and Lake Van Norden and the acquiring of the Towle water system, including Valley Lake. Now the company has in operation for use in the fruit district of Placer county about 265 miles of ditches, pipes, and flumes and a storage capacity of 1,036,000,000 cubic feet, by means of which it distributes to the growers about 1800 miner's inches of water each day of twenty-four hours from May 1st to September 1st. This water irrigates approximately 13,500 acres, the consumption being one inch for 5 to 10 acres and averaging about one-inch to 7½ acres. The annual product of this irrigated land amounts to about 2,500 carloads of 24,000 pounds each, 80 per cent of which is shipped east and north and sold in the fresh state, the balance being either sold for canning or dried. About one acre in three in the district covered by this system is now under cultivation.

The conditions are materially different from nearly, if not all, the other irrigation systems of California, in that the hilly nature of the ground to be irrigated and the distance the water has to be conveyed from the source of supply to the point of distribution renders flooding or the use of large heads impracticable and makes it necessary for each consumer to run a smaller head and use it continuously, shifting it from one part of the orchard to the other as occasion requires.

Taking into consideration the fact that any variation, at the source or along the line of ditch, by reason of leakage in pipes, flumes, or ditch, produces a proportionate variation at the ends of the distributing ditches, it is obvious that it requires the greatest watchfulness and care upon the part of the employees, from the greatest to the least, to the end that each consumer may receive his regular supply from May 1st to September 30th without wasting a considerable quantity of water in the process.

To overcome this, and also the variation caused from evaporation arising from differences in temperature, the company has from time to time constructed reservoirs at or near the lower ends of the distributing ditches to act as regulators. These, together with Lake Theodore on the Boardman ditch and Lake Arthur on the Fiddler-Green ditch enable them to give a very efficient service.

Only once since 1894, when the writer entered the employ of the company, has there been any serious interruption of service. That once was in August, 1905, when a break and slide in the bank of the Bear River ditch rendered it necessary to transport the material 13 miles and build 450 feet of flume, 5 feet wide and 5 feet deep. This was done and the water turned in again in ten days' time.

THE WATT-HOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

(Continued.)

CHAPTER III.

THE INDUCTION METER.

At the present time the induction type of watt-hour meter is used almost exclusively where alternating currents are concerned, and as alternating current is much more extensively used for general lighting and power distribution than is direct current, there are considerably more induction meters being manufactured than there are of any other type.

Reasons for Its Extensive Use.

Some of the principle reasons for this almost exclusive use of the induction meter on alternating current circuits are as follows: The induction meter is more rugged in design, having no brushes, no commutator, or other moving contacts. The revolving element consists simply of the shaft and revolving disc, all windings being on the stationary element.

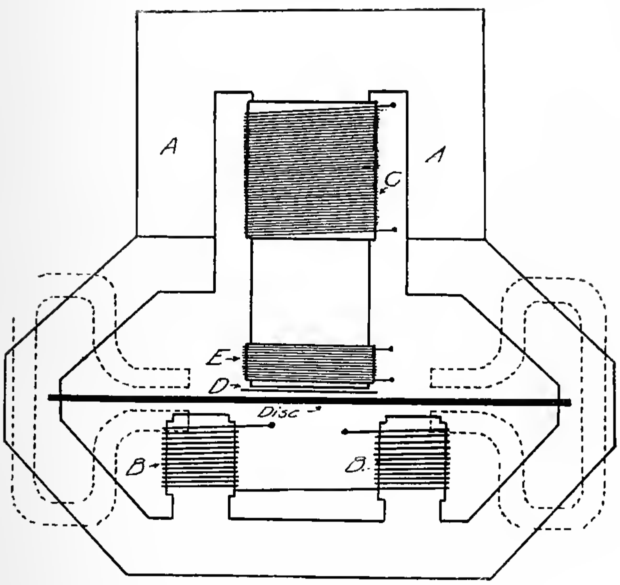


Fig. 15.

The weight of the moving element being less than that of the commutating type of meter, and the fact that it has no commutator with its resulting friction, necessarily eliminates an appreciable amount of friction and also results in less jewel wear.

For the above reasons, the induction meter will maintain its accuracy better with the same amount of attention than will other types of "motor" meters.

The induction meter is entirely free from commutator and brush troubles, having neither brushes nor commutator. It is cheaper in first cost than any other type of meter, suitable for use on alternating currents, which can compare with it in continued accuracy.

Principle of Operation.

The induction meter consists essentially of the stationary element, the rotating element (consisting merely of the shaft and disc), the recording mechanism, the jewel bearing and the retarding magnets.

The stationary element consists of the magnetic circuit, A, Fig. 15, which is built up of laminated steel punchings; the current coils, B; the potential coil, C; the light load adjustment, D; and the lagging coil, E. The current and potential coils are mounted as shown in the figure, in such a way that the magnetic flux set up by each of these coils will pass through the meter disc, and this alternating flux passing through the metallic disc will set up currents therein which will flow as indicated in Fig. 16, the disc acting virtually as the short-circuited secondary of a transformer. It will be seen from Fig. 16 that the currents set up in the disc by the potential coil P flow past the poles of the current coils, P[1], and that the currents set up by the current coils flow past the pole of the potential coil. These currents set up in the disc are in phase with the voltages producing them, since the circuit offered by the disc itself is non-inductive. The voltages in the disc which produce these currents, however, lag 90 degrees behind the fluxes set up by the coils on the stationary element, as an induced voltage is always 90 degrees behind the inducing flux. The flux is in phase with the current which produces it, the angle of hysteretic lag being negligible, so that we have currents flowing in the disc lagging 90 degrees behind the currents flowing in the meter windings.

The potential coil is wound with many turns of fine wire, and is therefore highly inductive, so that the current flowing in this coil is practically 90 degrees behind the impressed e.m.f. and the flux from the pole of the potential coil is brought to exactly 90 degrees behind the impressed e.m.f. by use of the lagging coil,

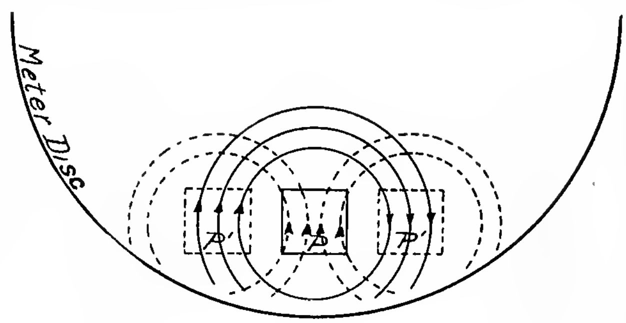


Fig. 16.

as will be explained later. The flux from the poles of the current coils will be in phase with the current, and therefore in the case of a load of unity power factor will be in phase with the impressed e.m.f. It can be readily seen from this that in the case of unity power factor the current set up in the disc by the potential coil (which lags 90 degrees behind the flux from the potential coil), will be in phase with the flux from the current coils, and also that the current set up in the disc by the current coils will be in phase with the flux from the potential coil. It will further be seen by referring to Fig. 16 that the disc currents set up by the potential coil will flow past the center of the current coil poles, and that the disc current set up by the current coils will flow past the center of the potential coil pole. This will give rise to a mechanical force tending to cause the disc to revolve, since any conductor carrying current at right angles to a magnetic field is subjected to a force which tends to move the conductor out of such field. Furthermore, this force

is proportional to both the current flowing in the disc and to the field strength or to the product of these two factors. In the case of the meter the current flowing under the pole of the potential coil is proportional to the line current, and the flux is proportional to the impressed e.m.f. Similarly, the current flowing under the poles of the current coils is proportional to the impressed e.m.f. and the flux from the current coil poles is proportional to the line current. The force tending to revolve the disc is therefore proportional to twice the product of the current and the voltage, or what is the same thing, it is proportional to the product of the current and voltage, or to the watts.

The principle of the induction meter's operation may be explained in a somewhat different way, which is perhaps more clearly understood; that is, the electrical element may be considered as the stator of an induction motor and the disc as the rotor. The "shifting" magnetic field in the case of a meter (which corresponds to the "revolving" magnetic field of the motor), is supplied by the current coil and the potential coil poles, the flux from the potential coil pole being 90 degrees out of phase with the flux from the current coil poles, as previously explained. This "shifting" magnetic field sets up currents in the meter disc, which reacting with the magnetic field produces a force tending to rotate the disc, exactly as the "revolving" field of an induction motor sets up currents in the rotor, which reacting with the "revolving" magnetic field produces a torque which causes the motor to run.

In the case of power factors which are other than unity, the flux produced by the current coils (which flux is in phase with the current), will no longer be 90 degrees out of phase with the flux from the potential coil, but will be 90 degrees plus or minus the angle of current displacement or the angle by which the current is out of phase. This being the case, the disc currents set up by these coils will no longer be in phase with the flux from the poles under which they flow, but will be out of phase by the angle of current displacement. The force tending to turn the disc will therefore no longer be directly proportional to the product of the current and the flux, but it will now be proportional to the product of the current, the flux and the cosine of the angle of current displacement, which is the power factor. Therefore the meter will still register the true watt-hours.

Another way of expressing this is to consider that the force acting on the disc will be proportional to the product of the flux and the component of the disc current which is in phase with the flux. Since the disc current is out of phase with the flux by the angle of current displacement, the component of the disc current in phase with the flux is equal to the total disc current multiplied by the cosine of the angle of displacement, or the power factor.

Lagging for Low Power Factor.

In order for the meter to register correctly on low power factors it is necessary for the flux from the pole of the potential coil to be **exactly** 90 degrees behind the impressed e.m.f. If the flux from the potential pole is less than 90 degrees behind the impressed e.m.f. the meter will run slow on lagging and fast on leading currents, while if the flux lags more than 90 degrees it will run fast on lagging and slow on leading currents. This condition is obtained by a method known as lagging, and is accomplished as follows: In figure 15 C is the potential coil, and E is the lagging coil which is mounted over the pole tip of the potential coil. The current in the potential coil will be not quite 90 degrees behind the impressed e.m.f., due to the RI^2 losses in the winding and the losses in the iron which give rise to an energy component of the current. The flux will be in phase with the current, and will therefore be not quite 90 degrees behind the impressed e.m.f. A part of this flux will pass through the lagging coil and on through the meter disc. This flux induces an e.m.f. in the lagging coil which is 90 degrees behind it in phase. This is shown by the vector diagram, Fig. 17. In this diagram OE represents the impressed e.m.f. and OI the current in the potential coil which lags not quite 90 degrees behind this e.m.f. $O\phi$ represents the flux set up by the current, which passes through the lagging coil and meter disc. This flux induces the e.m.f., OE', in the lagging coil, which is 90 degrees behind it in phase. The circuit of the lagging coil is closed through a resistance, the amount of which can be varied and therefore the amount of current flowing in this circuit

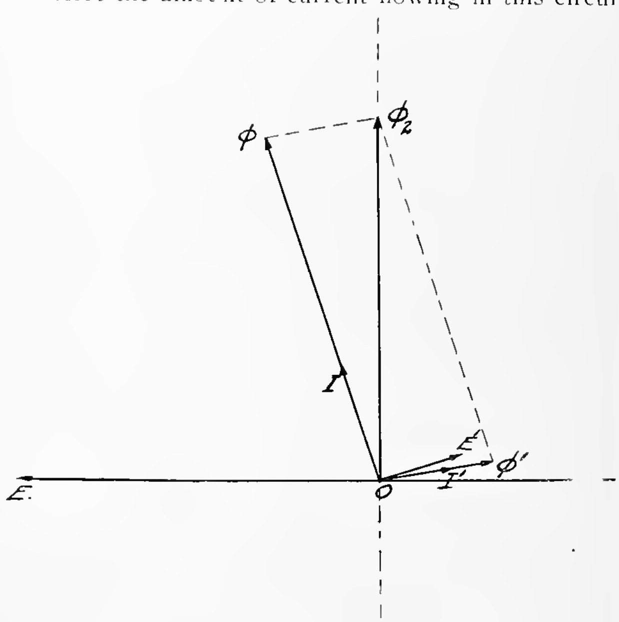


Fig. 17.

can be varied. This current is represented in the diagram by OI'. The current OI' will set up a flux $O\phi'$ in phase with itself, and this will combine with the flux $O\phi$, producing the resultant flux, $O\phi_2$, which will pass through the meter disc. It can be readily seen by reference to the figure that if the current, OI' is of the proper value, that this resultant flux $O\phi_2$ will be exactly 90 degrees behind the impressed e.m.f., OE. By adjusting the amount of non-inductive resistance in the circuit of the lagging coil, this condition can be very easily produced, which process is known as "lagging." A properly lagged meter will register with accuracy on low power factor. The method of lagging above described is used in meters manufactured by the General Electric Company.

The method of lagging which is employed in meters manufactured by the Westinghouse Electric

and Manufacturing Company is somewhat different from that which has just been explained, though the principle is essentially the same. In the Westinghouse meter the lagging coil consists of an adjustable short-circuited turn, placed on the pole tip of the potential coil. The position of this turn can be adjusted so as to obtain the required flux component to bring the resultant flux 90 degrees behind the impressed e.m.f. By referring to Fig. 18 it will be seen how this is

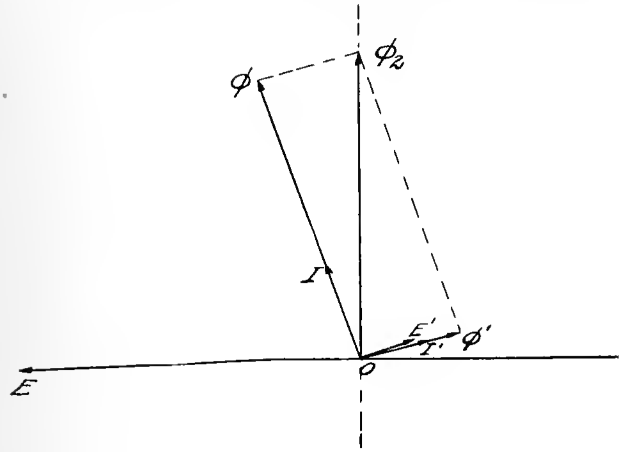


Fig. 18.

accomplished. OE represents the impressed e.m.f., OI, the current in the potential coil, OE', the voltage induced in the short-circuited lagging turn, OI', the corresponding current, and $O\phi'$ the flux set up by this current. $O\phi_2$ represents the resultant flux which lags 90 degrees behind the line e.m.f. The proper value of the flux, $O\phi'$ can be obtained by varying the position of the short-circuited turn.

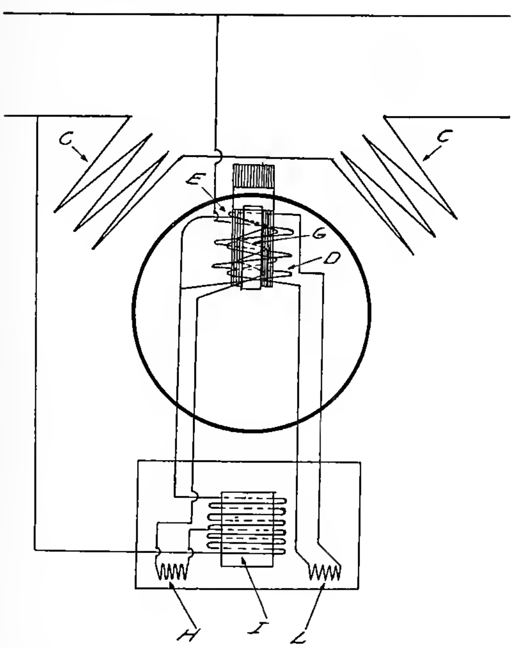


Fig. 19.

In the induction meter manufactured by the Fort Wayne Electric Works, the lagging device consists of two elements, one being wound on the light load adjusting arm (shown at G, Fig. 19), and is connected in series with the lagging resistance, H. This coil and resistance is shunted across a portion of the potential winding as shown. The other coil, E, is wound on the potential pole tip and is short-circuited through a resistance, L. In the vector diagram, Fig. 20, OE is the impressed e.m.f., OI, the current flowing in the potential circuit, which lags not quite 90 degrees behind the voltage, and $O\phi$ is the flux produced by this current.

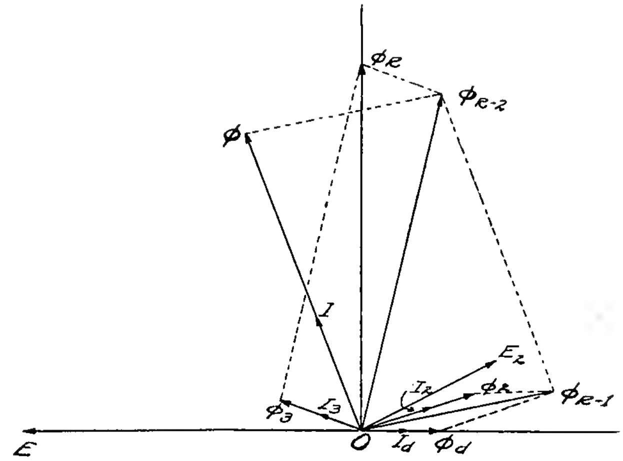


Fig. 20.

This flux produces the voltage OE_2 in the lagging coil, E, which in turn sets up the current OI_2, and the flux, $O\phi_2$. The current induced in the meter disc by the potential coil also sets up a flux, $O\phi_d$, in phase with itself. The resultant of $O\phi_2$ and $O\phi_d$, which is represented by $O\phi R_{-1}$, combines with $O\phi$ giving the resultant flux $O\phi R_{-2}$, which lags more than the required 90 degrees, and this is brought to exactly 90 degrees by the flux $O\phi_3$ set up by the coil, G. The flux $O\phi_3$, being almost in phase with OE, the voltage impressed on the coil being in phase with OE, and the circuit being closed through a non-inductive resistance. The proper amount of lagging is accomplished by adjusting the resistances H and L, which changes the values of the currents OI_2 and OI_3, and therefore the fluxes produced by them. Coil L is left open-circuited when used on 133 cycles, the flux from the meter disc producing the necessary lagging effect in conjunction with the coil, H. Such a meter as just described is "double lagged," since the 60 cycle meter can be used on 133 cycles by simply open-circuiting coil L.

Light Load Adjustment.

The light load adjustments of the various makes of induction meters on the American market are very similar in principle of operation, as is also the case with the power factor adjustments. The different manufacturers, however, use somewhat different methods of applying the fundamental principle as will be seen in the following descriptions:

The light load adjustment clip of the General Electric induction meter is shown at A in Fig. 21, and consists of a rectangular copper conductor which acts as a short-circuited loop, being so mounted that it can be shifted in a plane at right angles to the axis of the potential pole. This short-circuited turn has an e.m.f. induced in it, by the flux from the potential pole tip, which in turn sets up a current that is practically in

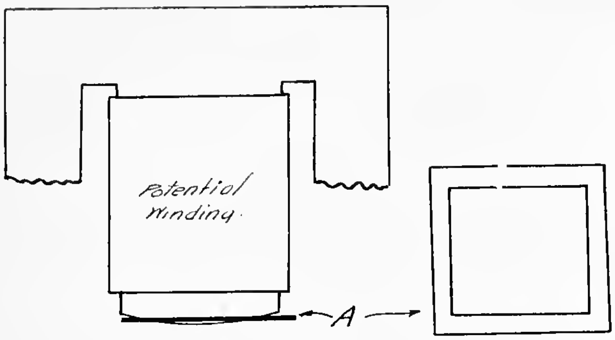


Fig. 21.

phase with this e.m.f.; the current produces a magnetic field which is out of phase with the flux from the potential pole. This flux from the light load adjusting coil reacts with the main flux from the potential pole tip and thus produces a turning effort which acts upon the meter disc. The amount of this turning effort can be varied by simply shifting the short-circuited turn, so

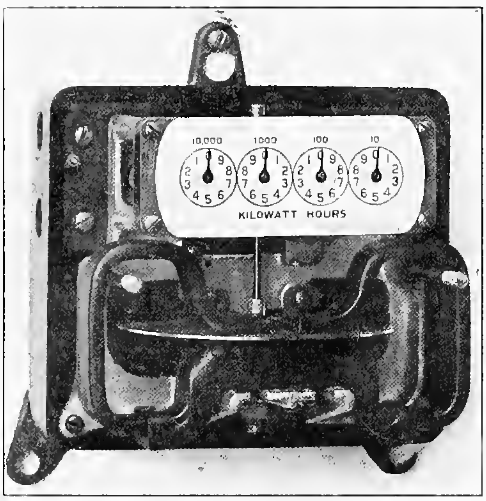
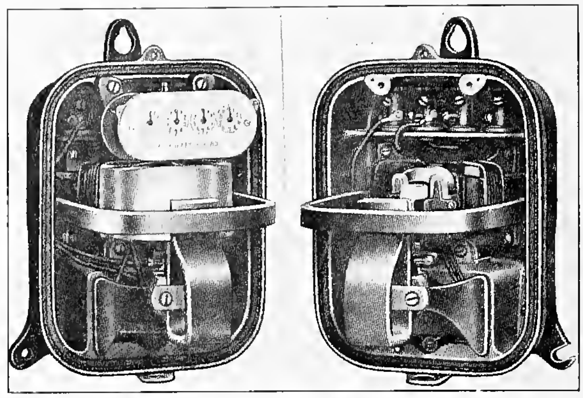


Fig. 22a.

that there will be a mechanical as well as a time phase displacement between the flux from it and that produced by the potential pole. The illustrations in Fig. 22 (a and b) shows clearly the construction of the General Electric Company's single phase induction meter



a Fig. 23. b

for ordinary house use, from which a general idea may be had of the parts entering into the construction of a typical induction watt-hour meter.

The light load adjusting device of the Fort Wayne induction meter consists of a laminated iron arm which forms part of the potential pole, and upon which is mounted the short-circuited coils. The position of this arm can be shifted, the effect being similar to that described for the General Electric meter. Figure 23 is an illustration of the Fort Wayne company's single phase meter, and, as will be noted, the disc has a peculiar "cup-shaped" form. The illustration at (b) shows the ease with which the disc may be removed without disturbing other parts of the meter.

The light load adjusting device of the Westinghouse induction meter consists of two adjustable short-circuited turns so mounted that they may be rotated through a small angle. One side of each of these short-circuited turns is in an air-gap in the magnetic circuit

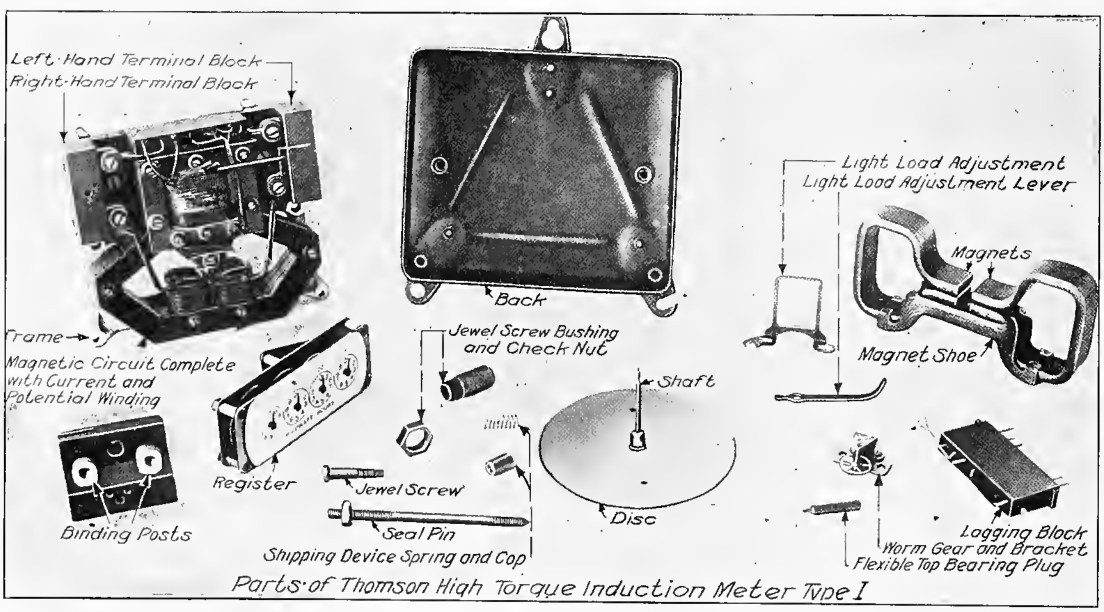


Fig. 22b.

of the potential winding and by partially rotating the turn it can be made to enclose more or less lines of magnetism, as can be readily seen from the diagram in Fig. 24 at A. The lines of magnetism, in passing through the short-circuited turns, induce currents therein, which currents set up an auxiliary field. This

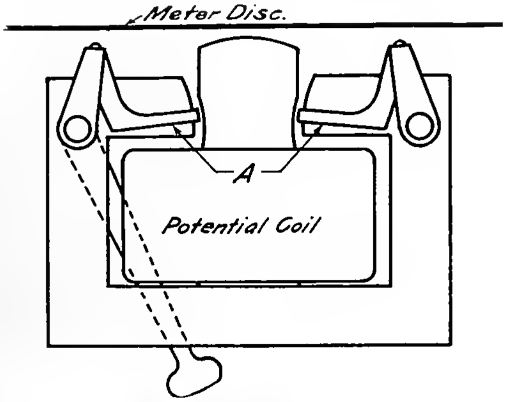


Fig. 24.

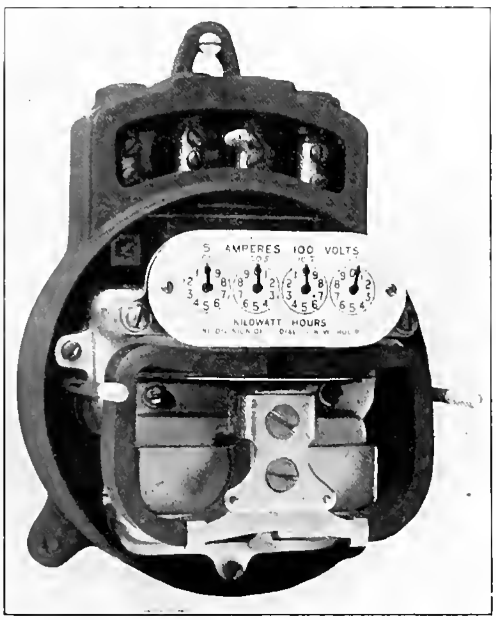


Fig. 25a.

auxiliary field is out of phase with the main field from the potential pole, and the two, acting in conjunction, produce a torque on the meter disc, the amount of which can be varied by moving the short-circuited turns so that they will embrace more or less of the flux passing through the air-gap. In Fig. 25 (a and b) are shown two views of the single phase type of induction meter as manufactured by the Westinghouse company.

The object of the light load adjusting device is to produce a torque from the potential circuit alone (independent of the load on the meter), the magnitude of which will be just enough to overcome the friction of the meter, therefore rendering it accurate on light loads.

Creeping.

If the light load adjustment is set so as to exert a torque greater than is actually necessary to overcome the friction it will cause "creeping" on no load. Creeping will also result if the light load adjustment is properly set for operation at normal voltage and then the meter installed on a circuit where the voltage is considerably above the normal voltage rating of the meter. A higher voltage will produce a higher flux from the potential pole, which in turn will induce a higher current in the light load adjusting coil, and this higher current and higher flux will mutually react and produce a higher no load torque, thereby causing the meter to creep.

Effect of Frequency Variations.

When an induction meter is operated on a frequency other than that for which it is adjusted, the lagging coil will no longer set up just the necessary flux to bring the resultant flux from the potential pole exactly 90 degrees behind the impressed e.m.f.; it will either be ahead or behind this correct 90 degree position, depending upon whether the frequency is below or above the normal value. Errors from this source will be inappreciable so long as the frequency is within 10% (approximately) of the normal value.

It is at the present time the practice of the leading meter manufacturers to design their 125 cycle and their 133 cycle meters so that by a simple connection

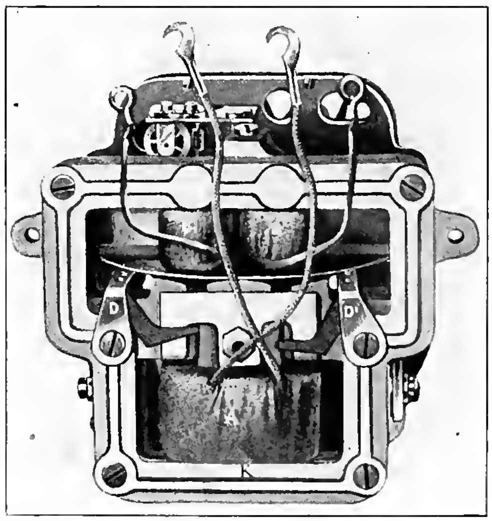


Fig. 25b.

or adjustment, which can be easily made, they may be used with accuracy on 60 cycle circuits. This is on account of the fact that 60 cycles is the standard lighting and power frequency, and as the majority of the higher frequency plants will sooner or later be changed over to 60 cycles, it will evidently be a great saving to them if they can use their old meters rather than have to purchase new 60 cycle meters when such a change may be made. Meters so constructed are known as "double lagged" meters, since they are lagged at the factory for two different frequencies.

The effect of a frequency other than normal can be best shown by reference to the diagram shown in Fig. 26, in which

OE=the impressed e.m.f.,
OI=current in potential coil at normal frequency,
OI_1=current in potential coil at low frequency,
OI_2=current in potential coil at high frequency,

OI_L, OI_{L-1} and OI_{L-2} = the currents in the lagging coil for these different frequencies.

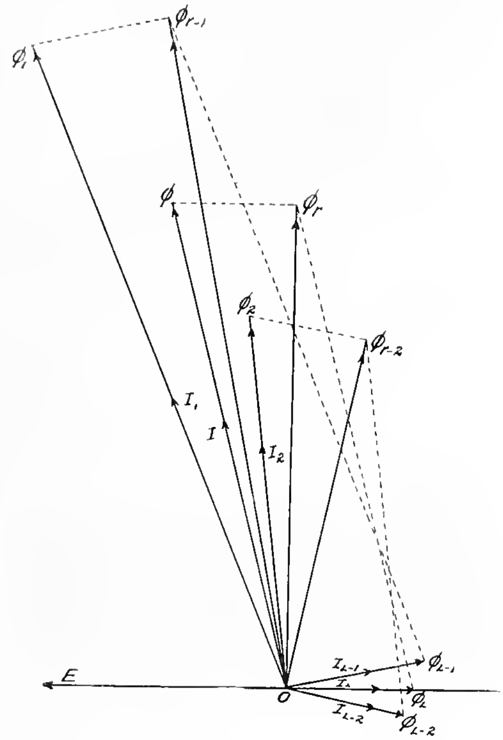


Fig. 26.

Now suppose that the meter is properly lagged for a frequency, f, the current in the potential winding being OI, and the flux therefrom being $O\phi$. The current in the lagging coil will be OI_L, and the flux therefrom will be $O\phi_L$; these two fluxes, $O\phi$ anc $O\phi_L$ combine to produce the resultant flux $O\phi R$, which is exactly 90 degrees behind the impressed e.m.f. Now suppose that the meter is used on a frequency, f_1, which is below normal. With a lower frequency the flux set up by the potential coil will be greater, as the rate of change of flux must remain the same. The magnetizing current, OI_1, will therefore be greater, the core loss and the RI^2 losses will be higher, so that there will be a larger energy component of the current, and it will therefore not lag by as great an angle as with normal frequency; the current OI_1 sets up the flux $O\phi_1$, which represents the condition for a frequency below normal. The flux, $O\phi_1$, combining with the flux $O\phi_{L-1}$, set up by the lagging coil at the lower frequency, produces the resultant flux $O\phi R_{-1}$, which does not lag to the 90 degree position, and in order that it be made to lag to the correct 90 degree position, it is necessary for the lag coil to set up a greater flux than $O\phi_{L-1}$, which can be accomplished by relagging the meter for this lower frequency, f_1.

Now in the case of a higher frequency, f_2, the current in the potential winding is represented by OI_2, and the corresponding flux by $O\phi_2$. Both the core loss and the RI^2 losses in the potential winding will now be less than in the initial case, the energy component wil' therefore be less, and the flux will lag more nearly to the correct 90 degree position. The flux, $O\phi_{L-2}$, now set up by the lagging coil, will combine with the flux $O\phi_2$, producing the resultant flux $O\phi R_{-2}$, which lags too much, being beyond the 90 degree position. In order for the resultant flux to lag to the correct position, it will therefore be necessary for the lagging coil to set up a flux less than $O\phi_{L-2}$; in other words, the meter would have to be relagged for this higher frequency, f_2.

Obviously, for power factors other than unity, serious errors would be introduced by using a meter adjusted for a frequency different from that of the circuit on which it operates; the meter might either run fast or slow, depending upon whether it is adjusted for a higher or lower frequency than that of the circuit on which it operates, and upon whether the current is lagging or leading.

The effect of a frequency above normal will be to make the meter run fast on lagging currents and slow on leading currents; a frequency below normal will cause the meter to run slow on lagging currents and fast on leading currents. For unity power factor there would also be an error introduced, although it would not be so pronounced as in the case of power factors other than unity. In this case only that component of the flux from the potential pole which is in the correct 90 degree position will be effective, so that the phase displacement of the resultant flux will tend to make the meter run slow on any frequency other than that for which the meter is adjusted. The values of the resultant fluxes are not strictly proportional to the frequencies, however, since the component supplied by the lagging coil is not proportional to the frequency and its angular relation to the main component is different for the different frequencies; also for lower frequencies, the energy component of the voltage is greater and the reactive component is less, due to the increased shunt current which tends to make the meter run slow, and vice versa for higher frequencies.

The currents induced in the meter disc by the current coils should be directly proportional to the frequency, but due to the demagnetizing effect of these currents on the current coil poles, this condition is not strictly fulfilled, which causes the meter to have a tendency to run slow on frequencies above normal and fast on frequencies below normal.

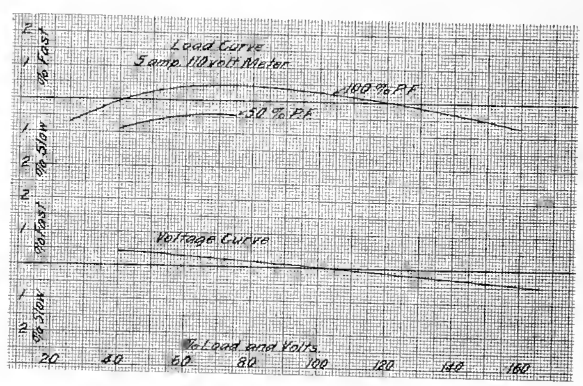


Fig. 28.

The resultant effect of the different disturbing factors above mentioned will affect the meter to an extent dependent largely upon the design.

Figure 27 is a curve showing the accuracy of a

Fig. 27.

standard make of induction meter on different frequencies at unity power factor, and Fig. 28 shows the load and voltage curves of a standard 5 ampere induction meter operating at normal frequency.

(To be Continued.)

CARE OF HIGH-VOLTAGE INSULATORS.

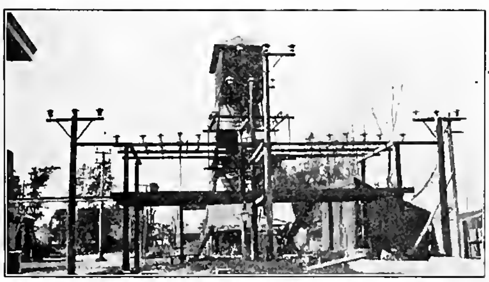
BY J. O. HANSEN,

Superintendent Pacific Gas and Electric Company's San Jose Power Division.

J. O. HANSEN

The large insulators, supporting the wires and insulating the high-voltage currents on the transmission lines, while ordinarily performing their peaceful allotted duty, are are at the same time doing strenuous work, and, if not properly cared for become overburdened. Then there is at the best a momentary disturbance. It is noticed on the lights as a blink or on the motors as a groan.

On the system of the Pacific Gas and Electric Company there are more than 100,000 high-voltage insulators. Their efficiency must be great to avoid an average of one breakdown a week, and even that is too frequent. But at this rate the average life of an insulator would be nearly 1,000 years. This, of course, is



Insulators on Switches at Petaluma.

not reckoning on breaks due to mechanical causes. The small boy with a stone is often the most frequent cause for a mechanic on the job, and the small boy is closely seconded by the unsuccessful hunter who must use his ammunition on something.

A few hundred insulators put under test will undoubtedly make a satisfactory showing. But there must be very general great reliability for all climatic conditions. In the intensely foggy and windy climate about San Francisco bay insulators are things that require careful watching and attention. Insulators made to stand a rain or wet test will render good service in fog and wind when they are clean, but, when dirty, their insulating quality becomes much impaired.

The heavy winter rains keep the insulators clean a part of the year. During a dry spell of from one to two months so much dirt will have collected on the insulators that when they become wet there will be enough current leak over to fire the pole. The soft redwood or cedar pole itself catches fire much more easily than the pine cross-arms. When iron pins are used, and are shorted by wire, the leakage current may be entirely between the wires over the insulators or the leak may be between a wire and the ground, and then fire the pole. But by running the shorting wire to the ground, the pole is thoroughly protected from such burning. Still the leakage current is present, and, if allowed to become large enough, through the wetting of the accumulated dirt by fogs or light rains, an arc forms which either shatters the insulator or burns the transmission wire in two. In the majority of cases

On the Pole Line Between Berkeley and Elmhurst.

either of these accidents is easier to repair than a burned pole. With the iron insulator pins shorted and grounded more current and consequently a greater accumulation of dirt and dampness are required to start trouble, so that more time can be allowed between cleanings of the insulators. The dirt accumulates over all parts of the insulator in an even layer. But an insulator that has been on the line through the winter has more dirt left on the protected parts than on the exposed parts where the rain has washed some of it off.

For this reason the suspension type of insulator is better than the pin insulators, because in the suspension type a larger percentage of the entire surface may be washed off by the rains. The method of supporting by a large clamp is also probably better than by a small tie wire on the pin insulators, because of the difference in corona discharges from small and large diameter surfaces.

First dry cloths were used in cleaning the insulators. Later it was found more effective to apply gasoline on the cloths to cut the dirt and grease. But because gasoline evaporates so quickly kerosene is now being used with good results. The best cleaning is with clear water applied with a hose. All parts are then washed off without any residue being left on the surface.

An insulator made to hold up under all of the dirt that will accumulate on it during a season and have its surface so exposed that the winter rains will thoroughly clean it, should give satisfactory results. The problem then presented is whether it will be cheaper to use small insulators and pay to keep them clean or use large insulators which will withstand the dirt and fogs through the summer and be automatically cleaned by the winter rains washing them.

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POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

CORRECTION:—Figs. 12, 13a and 13b in the chapter on "Watt-Hour Meter" appearing in the issue of March 5, 1910, are wrong. The connections from the neutral wire of 12 should be joined to all three meters, instead of to but one, as shown in the diagram. In 13b the lead from the load side of current transformer No. 2 should connect to the lower current lead of the meter. The connections of the current transformers in Fig. 13a should be the same as in 13b.

Talk Up

Local branches of the national engineering associations have been established in a number of Pacific Coast cities and unlike many similar organizations in the East, they discuss original subjects. These subjects are of especial concern to Western men, because they deal with problems peculiar to the West. Many of the matters presented in the Eastern meetings do not directly bear upon Western conditions. Likewise it may be said that some Western problems do not immediately interest Eastern men. It is, therefore, mete that the local sections, representing the best engineering talent of the community, should discuss those problems which are arising in their daily work.

The interchange of practical ideas in the ensuing discussions is frequently more valuable than those developed in the formal papers. Members are consequently encouraged to express themselves freely upon those subjects with which they are familiar. Unfortunately some men seem to be so constituted that they are fearful of talking on their feet. There is nothing more discouraging than for a speaker to carefully prepare a discussion which seems to fall upon deaf ears so far as any response is concerned. This apparent lack of interest is deplorable and calls for vigorous action in stimulating what should become the most important feature of these meetings.

Public Service Corporation

One by one in the different states of the union blossoms the public service board, the anemone of the reformer. After Massachusetts came New York and Wisconsin, with strong probability of like action in Maryland and New Jersey. The idea of a public service commission is contagious, and there are few state legislatures which will not be asked to pass on the matter during the coming sessions. Municipal control, state regulation and federal supervision combine to threaten a corporation over-regulation which may yet prove as disastrous as corporation over-capitalization. Such a movement carried to its extreme can be but a business detriment.

There are few thinking men who will deny the benefits of some authoritative check on corporation rapacity. In California, at least, municipal control has proved satisfactory to neither the public nor the corporation. Recent developments at Washington show that federal supervision is likely to prove a farce under the present provisions. The experience of Massachusetts, New York and Wisconsin proves that regulation has many desirable features. It limits that exhaustive competition which ruins legitimate investment, and it protects the stockholders from unwarranted expenditures. Its chief function, like that of the railroad commission, is rate regulation whereby consumers will be served at the lowest price consonant with fair returns on the money invested. If this beneficial regulation can be confined to the adminis-

tration of one set of commissioners and not diffused through a municipal, a state and a national body, it is likely to solve many pressing problems.

What It Costs

A careful and analytical study of the report upon the Pacific Telephone and Telegraph Company for the year 1909, made for the City of San Francisco by C. L. Cory and published in the March 5th issue of the "Journal of Electricity, Power and Gas," should be of benefit to engineers, stockholders in such companies, and the customers of public service corporations. One need not be interested in the facts and figures there presented, referring to the telephone industry only, to appreciate the necessity of every successful corporation giving attention to the details of their business, not only to the physical equipment and the operation of the system, but also to the methods of accounting required to accurately determine unit costs.

Referring to a single set of figures obtained as a result of the investigation and included in the report, it is stated that the average revenue or amount paid by the customer per telephone station per month, covering a period of two years, divided, however, into four equal periods of six months each, was as follows:

January to June, 1908, per month..........	$4.233
July to December, 1908, per month........	3.714
January to June, 1909, per month..........	3.689
July to December, 1909, per month........	3.492

In referring to these figures the report sets forth that the reduction in the revenue per telephone station, or the reduced cost to the customer of the telephone service, is due in part to the reduction in rates and in part also to the increase in the number of telephones installed and operated, meaning thereby that the capacity of the system as at present installed is being more nearly completely utilized.

It is needless to say that every corporation should not only keep careful and accurate accounts properly segregated, but in addition should use the results of the analysis of these accounts to plan for the future, so that it will not be necessary to hastily and under great stress do temporary and, in the end, expensive work in order to keep pace with increased business, but, on the other hand, with as many facts before them as are obtainable, plan each year's work ahead so that the required extensions will be of a permanent character and in conformity with the plant as a whole.

Economy is a word which probably means as much to the engineer as to any individual. To improve the economy of operation is the constant work of many engineers. Manufacturers consistently try to build apparatus of the highest possible efficiency, but it is certainly apparent that without wise and far-seeing management in the building and extending of the plant and system of a company, all the apparent saving in the purchase and installation of the most efficient apparatus would be more than wasted by careless or unwise management in the construction and operation of the system.

Conclusions for the guidance of the directors, managers and engineers of such a company can only be of use if based upon facts and sufficiently reliable information so that the results will be in accordance with the ultimate requirements. What is required is good judgment in estimating for the future. Unfortunately, instead of systematically and in detail keeping accounts, the analysis of which will be of value, disastrous results often come from pure off-hand guessing, and it is not surprising that in such cases a time always comes when the failure to first obtain facts results in ultimate disaster.

Consumers very seldom, if ever, give thought or credit to the work of the men who are continuously occupied with such problems. It requires constant effort, a broad perspective and the ability to wisely balance many divergent and complex elements to arrive at approximately correct conclusions even with every possible fact available. Increased economy and reduction in the unit cost of operation is being obtained every day, and it is unfortunate indeed that sufficient publicity is not given by the corporations to such matters so that their customers may appreciate what is constantly being done in their behalf. Increased quality of service, coupled with decreased cost, has resulted in the past and will continue in the future as long as the state of the art improves and an advance in science and engineering continues.

A United States senator whose name has been very conspicuously identified with the recent tariff bill is responsible for the assertion that the affairs of the United States government are run at a cost to the people three hundred million dollars in excess of what the administration would cost if conducted with the economy of the large corporation. Whether this assertion is true or not, it must be admitted that federal, state, county and municipal affairs are not efficiently and economically administered.

Perhaps it may be due to the employment of men not particularly fitted or trained for the work they are supposed to do, since they hold their positions in many cases as a result of favoritism rather than effectiveness. If in such matters complete accounts showing unit costs were insisted upon by those in general charge, the real cause of the inefficiency of such institutions would certainly become more apparent, and it must be remembered that in the procuring of the best data, time is often a necessary element, and when continuous records can be obtained and compared there is a real hope of surely and unquestionably proceeding in the right direction.

PERSONALS.

H. F. Brizard of the Arcata Light & Power Co., of Arcata, Cal., is in San Francisco.

H. C. Thaxter has joined the sales engineering force of Woodin and Little of San Francisco.

Sidney Sprout, electrical engineer, returned during the week from a trip through the Northwest.

C. E. Condit, president of the Nevada Machinery Co., of Reno, Nevada, was a recent visitor in San Francisco.

C. R. Ray, who has extensive electric power interests in Southern Oregon, is a recent San Francisco arrival from Medford, Oregon.

Russ Wolden, of the California Electrical Construction Company, San Francisco, has returned to business, after having been ill for the past six months.

G. A. Schneider, engineer with the San Francisco office of the Western Electric Company, recently went to Lovelock, Nev., on engineering work.

N. H. Dohrman, who went to Parral, Mexico, a few months ago as manager of a new electric light and power plant, has returned to San Francisco on a visit.

William D. Ward, of the sales force of the Pelton Water Wheel Company, of San Francisco, has returned from a successful trip to Southern California.

W. S. Heger, the new manager of the Allis-Chalmers Company's San Francisco office, returned from the South during the week, after visiting his Los Angeles office.

R. S. Masson, engineer of the Electric Operating & Construction Company, recently passed through San Francisco bound for Portland and is now on his way to New York.

K. Casper, of Vallejo, who is at the head of the distributing company that distributes the current of the Pacific Gas & Electric Co., was a San Francisco visitor during the week.

Charles L. Zahn has been made engineer in charge of the construction of the Independent telephone properties at Spokane, Wash., controlled by Thaddeus S. Lane and associates.

Frank J. Campbell, of Denver, has been elected president of the Nevada-California Power Company, in place of Delos A. Chappelle, resigned. Mr. Campbell will make his headquarters at Goldfield, Nevada.

A. S. Kalenborn, chief engineer of the Truckee River General Electric Co., of Reno, Nevada, recently addressed the engineers' club of the University of Nevada, on the subject of the company's system.

H. L. Jackman, manager of the Humboldt Gas & Electric Company, of Eureka, Cal., was among the visitors to San Francisco during the past week. Eastern capitalists have an option on the holdings of his company.

Wynn Meredith, who is at the head of the San Francisco office of Sanderson & Porter, recently left New York on his return trip. He is taking the southern route and will stop off for a few days in Los Angeles.

George R. Murphy, sales engineer with Pierson, Roeding & Co., has returned from the East, where he perfected arrangements whereby Pierson, Roeding & Co. take over the Pacific Coast offices of the Electric Storage Battery Co.

Leon M. Hall, consulting engineer for the Comstock mines, has returned from Virginia City, where he inspected a new electrically-driven centrifugal pumping installation in connection with the mine drainage system of the Comstock Lode.

C. W. Stone, assistant engineer of the lighting department of the General Electric Company, of Schenectady, and D. R. Bullen, manager of the company's supply department, have gone to Southern California after spending several days in San Francisco.

Announcement

The rapidly increasing business interests of the Journal of Electricity, Power and Gas throughout the East have for some time required more prompt attention and better service than has been possible in handling such business from the San Francisco office. On this account we have established an eastern office at 150 Nassau St., New York, in charge of *Mr. C. N. Manfred*. Mr. Manfred is so well known among eastern advertisers that an introduction is hardly necessary. His long and active career in advertising work as advertising manager for the Ohio Brass Co., of Mansfield, Ohio, and later with the H. W. Johns-Manville Co., New York, in a similar position, is well known to many of our advertisers and readers. We feel extremely fortunate in securing Mr. Manfred to represent the Journal in the East, as we know that his experience will be of considerable benefit to both our present and prospective advertisers.

BANQUET OF LOS ANGELES ELECTRICAL MEN.

A joint banquet of the American Institute of Electrical Engineers and the Sons of Jove is to be held at the Hollenbeck Hotel on March 12, 1910. The speakers announced are: J. A. Lighthipe, "Early Days in Thomas A. Edison's Laboratories;" E. R. Northmore, "The Lighting Companies;" C. W. Koiner, "The Institute;" E. F. Scattergood, "Engineering;" O. H. Ensign, "Reclamation Service;" A. W. Ballard, "Sons of Jove."

BOOKS RECEIVED.

"Gas, Gasoline and Oil Engines," by Gardiner D. Hiscox. 450 pages, 6x9 inches, 412 illustrations. Norman W. Henley Publishing Co., 132 Nassau St., New York City, and Technical Book Shop, San Francisco. Price, $2.50.

The appearance of the eighteenth edition of this well known compendium of the gas engine vouches for its usefulness and requires little comment from the reviewer. The present edition has been so revised, rewritten and augmented that it is as representative of modern practice as it is possible for a text-book to be. The most important additions are in a new section on producer-gas plants and one on oil-vapor motors.

Illumination and Photometry. By W. E. Wickenden; 195 pages; 6x9 in.; 114 line illustrations, numerous tables. McGraw, Hill Book Co., New York City, and the Technical Book Shop, San Francisco. Price, $2.00.

This volume is intended as a text-book on the subject of illuminating engineering, and consequently considerable space is devoted to the scientific basis of the subject. It is sub-divided into fifteen chapters and an appendix. The subjects treated include the theory of light and of optics, photometry, the various types of electric and gas lamps and the practical calculation of illumination for both interior and exterior needs. The appendix contains tables and charts facilitating computation and estimating. Most of the treatment pre-supposes a knowledge of elementary physics and chemistry and an understanding of the calculus. To mathematics is due much of its admirable clarity and brevity. The treatment appears comprehensive, embracing as it does all practical methods of illumination and its calculation. When comparisons are made the utmost fairness has been employed as to the advantages and disadvantages of various types of illuminants. As a whole it is a valuable addition to the literature on illuminating engineering.

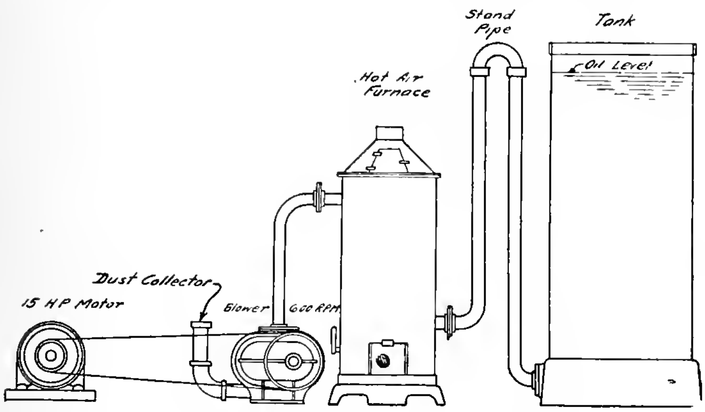
INDUSTRIAL

A NEW OIL AND TRANSFORMER DRYING DEVICE.

It is almost impossible to prevent moisture from being deposited in transformers during transportation or storage, as condensation takes place on the surface of the oil and metallic surfaces whenever these are cooler than the surrounding air. It is of the utmost importance therefore that adequate means be provided for drying out the transformer and oil.

The device shown diagrammatically in the cut, designed for this purpose, is manufactured by the General Electric Company, and consists of a hot air furnace, positive pressure blower, dust collector, driving motor, and necessary piping, pulleys and belt. Hot air, free from dust, is forced into the transformer through the oil valve in the base of the tank.

The hot air furnace contains a 3-inch wrought iron coil suitably supported inside a sheet iron casting, the whole being mounted on a cast iron base. The furnace is designed much like a self-feeding stove, two doors being provided, one at the top of the furnace for the admission of fuel, and one at the bottom for removing the ashes and also regulating the draft. Wood and charcoal have proved in actual experience to prodnce satisfactory results as fuel, but hard coal may also be used if forced draft is provided, which can be easily accomplished, by tapping the pipe between the blower and the furnace. Standard 3-inch wrought iron piping is used throughout, but as it is procurable almost anywhere, only the connection between the blower and the furnace is furnished by the manufacturers. If the connections between the furnace and the transformer tank are of appreciable length it is advisable to cover them with heat insulating materials to prevent the loss of heat.



Oil and Transfomer Drying Apparatus.

The positive pressure blower has a normal capacity of 300 cubic feet of free air per minute delivered at a pressure of 6 lbs. per square inch, is designed for a speed of 600 r.p.m., and requires 15 h.p. to drive it when delivering normal output.

The dust collector or air filter, consists of a perforated sheet metal pipe 4½ in. in diameter, connected to the blower with a suitable elbow and forms the point of entrance of the air to the blower. Cheese cloth should be tied around the pipe so that the air in entering the blower may pass through it and the dust be retained in its meshes.

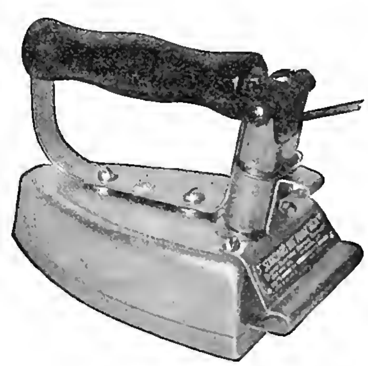
Any available power, as a steam engine, gas motor, electric motor, etc., will drive the blower satisfactorily. The piping between the furnace and oil tank is extended above the oil level to prevent flooding the furnace with oil if the valve in the base of the tank is not closed when the blower is stopped.

The method of its operation is as follows:

After the fire has been started in the furnace the fan should be put into operation. The air is drawn through the dust collector which frees it from all impurities and is then heated in the furnace to approximately 100 deg. C. The hot air being forced through the transformer and oil at a pressure of 6 lbs. per square inch, absorbs all the moisture and raises the di-electric strength of both the oil and windings to its original value. No hard and fast rule can be given as to the time actually required for thoroughly drying out the transformer, but it is believed for ordinary cases of moisture, that a 10-hour run after maximum temperature is attained, will be sufficient. Break-down tests should be made from time to time on samples of the oil taken from the transformer, and the drying continued until the oil is able to withstand a puncturing test, the value of which is prescribed by the transformer manufacturer.

A NEW ELECTRIC IRON.

The pretty electric iron shown in the accompanying photograph is the latest creation of the Pacific Electric Heating Company of Ontario, Californa, and Chicago. It has the same features that have made this electric iron so popular with the housewife heretofore: the cool handle, hot point, the attached stand, and guarantee.


Pacific Electric Iron.

A pressed steel top covers the entire iron, the asbestos mat included. A new steel encased plug has its insulation perfectly protected, and is practically indestructible. It has a patented method of attaching the cord, avoidng the usual wearing off of the insulation where the cord enters the plug.

Although the same principles of construction govern the making of the 1910 elements, they occupy less room, and when the pressure plate which holds them in place is removed, the elements can be lifted out. They lie loose in the bottom of the iron. The entire iron is given a sparkling mirror finish that is unusually attractive—a finish that electric iron makers previously have not thought worth while. This, with the ebonized handle of the 1910 Standard Hot Point Iron will have much to do with the big sales, the new iron will be sure to enjoy.

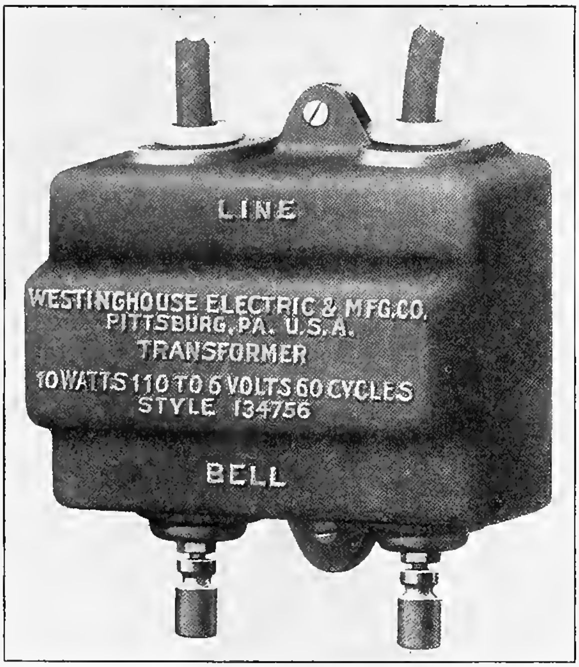
The Pacific Electric Heating Company is getting out a class of printed matter out of the ordinary for their dealers. Printed matter that is strong as well as attractive. The two year guarantee that has just been launched will have a more than ordinary pulling influence with the dealer. It is a guarantee directly between consumer and manufacturer. Nothing about it to bother or hold the dealer responsible.

The Pacific Electric Heating Company, as this edition is coming off the press, is announcing a series of laboratory tests made with three of the most widely known irons. Blue prints, and full details are being sent all dealers. And further still directions that the dealer may make the same tests for himself.

The Pacific Electric Heating Company is not putting out the only good electric iron on the market. But it certainly has an iron worth while, an iron that will stand the most severe tests—an iron that speaks for itself. The Hot Point Automatic model is the only electric iron fully approved by the National Board of Fire Uunderwriters. The Hot Point Standard and Automatic models were awarded grand prize (highest award) at the Seattle Exposition.

BELL RINGING TRANSFORMER.

Of course, you have experienced the time when you failed to receive an important telegram just because your door-bell was out of order and the messenger boy went away in disgust after almost breaking his knuckles in his efforts to call you. And you will be glad to know that a bell-ringing transformer has been brought out to displace the old-time batteries that have such a chronic habit of "running down." The



Bell Ringing Transformer.

new transformer brought out by the Westinghouse Electric & Manufacturing Company is a device that will permit the use of the regular lighting current in ringing your door-bell.

The advent of the bell-ringing transformer marks another wonderful stride in the application of electricity to modern life. It relieves another care and does so at a very small expense; it will displace five or six ordinary house batteries, and will last a life time. The operating cost is almost nothing. The original cost of this bell-ringing device compares favorably with that of the house battery system, and as it requires neither repairs nor renewal it is a much cheaper device in the end.

The Philadelphia Company of Pittsburg, Pa., has thrown out its batteries and is equipping its entire building next to the Public Safety Building, on Sixth avenue, with the Westinghouse bell-ringing transformers.

TRAIN DESPATCHING BY TELEPHONE.[1]

BY C. H. GAUNT.

We have not yet reached the stage of progress where one might ask, "Is the telegraph doomed?" Certainly it is not doomed when its application to the transmission of intelligence to great distances is taken into consideration nor when we reflect upon the great wireless projects of the future. But there is one direct use of telegraphy that is seriously disturbed, and that is its application to the necessities of modern train despatching.

The telephone has been in general use just about thirty years. At the very start the question was asked "Why cannot this improved means of transmitting words be used in the despatching of trains?" The grave and earnest men whose mental machinery seemed to work to perfection through the instrumentality of the telegraph said "No." The high officials of the railroads did not feel that the well working system was susceptible of change without risk, and risk is always to be avoided when there is not an immediate and good reason for assuming it.

Hardly a man of large influence in the field of train operation advocated the supplanting of the telegraph by the telephone during the first twenty-five years of the latter's successful use. Even after the clear long-distance transmitter had been generally established the railroad managers hesitated to interfere with the long wedded union of the telegraph with train movement. But the fine, practical minds of our great railroad managers have to be suddenly changed sometimes when a combination of circumstances brings about a result that has not been foreseen. Some may claim that the use of the telephone in despatching trains has long been advocated. Possibly so, but only during the last few years have trials been made of sufficient importance, and upon a large enough scale, to prove anything. When proof is demanded by a practical-headed train despatcher, it must be capable of but one construction—absolute.

The Santa Fe established its original telephone train-despatching circuit in June, 1908, in the dry climate of Colorado. It was not fitted with the improved apparatus now available, but there could be only one construction placed upon the reports received upon its operation—it was a success. As soon as this was realized immediate steps were taken to extend the introduction of the system to widely separated sections of the lines so as to test it in all conditions of climate. During the early part of 1909, 1962 miles of telephonic train-despatching circuits were in operation upon the Santa Fe Railway in the States of Missouri, Kansas, Illinois, Colorado, New Mexico and California. The longest circuit reaches from Fresno, Cal., to San Francisco, 203.1 miles, contains thirty-two stations and is successfully operated through the "fog belt" adjacent to San Francisco, where the telegraph is used only with great difficulty. The operating circuit upon all of these lines is a pair of 210-pound-per-mile copper wires carefully strung and costing in the neighborhood of $100 per mile. There is at present under construction 1520 miles more, which will give a total length of about 3482 miles of telephone circuits.

The results of this extensive trial, while really astonishing, should hardly be so considered, for they are but the natural consequence of human tendency, and an analysis of the telephone method will convince anyone that it will almost completely displace the use of the telegraph in moving trains, notwithstanding the expense of installation and the difficulty in overcoming the force exerted by the widespread use of the telegraph method.

The telegraph is used by the train despatcher in the intricate operation of his trains for one purpose only, that of communicating with the operators scattered along the stretch of railroad. Long use has developed a certainty of action in telegraph manipulation that commands the respect

[1]Santa Fe Employees' Magazine.

of all. But how often has a half frantic despatcher, loaded down with the complicated problems before him, wished he could use his voice to the men with whom he must communicate and thus avail himself of the rapidity of action, the definiteness and security that would follow?

To the despatcher time is the one thing that must receive the greatest consideration. It may be assumed that a man can utter words with a speed equal to the operation of his mind. But the train despatcher, in using the telegraph, has always been obliged to transmit his words at a speed but one-tenth his capacity to express himself, and also to receive a reply at the same rate. That being the case, of course a train-despatching system had to be adopted that would deal with a very small number of expressed ideas, and eternally and always the despatcher must come down to the limitations of the telegraph. In other words, the whole operation is inharmonious and does not tend to a result along the most natural channel. True, in the issuance of "orders" themselves, the speed, in telephonic manipulation, is limited to that required to write the words in longhand. But all directions of a collateral character, the receipt of important information and the instantaneous descriptions of situations that a despatcher must understand can be given and received at a speed limited only by that of human utterance.

And what does that mean? It means that the despatcher has been permitted to multiply the time within which he may form his plans of train operation fully three times. This, of itself, further means that his mental calculations are vastly improved in accuracy and general value. The despatcher is permitted to issue his orders at the times he originally outlined, and there is a coherence, a consistency and a union in his methods not possible where less time is available. This condition largely reduces the liability of error of action and, conversely, allows additional time for the discovery of error, important or unimportant.

By the use of the telephone the despatcher is relieved of that long continued and aggravating operation of calling an office by repeating over and over the telegraphic letter or letters used for that purpose. There is established at each office along the road, in the same circuit with the telephones, a small and compact instrument called a selector. Connected with the selector at each office is also an electric bell operated by a couple of cells of dry battery. The despatcher has within easy reach a number of buttons upon a board, each button being designated by the name of the station that it is designed to call. By merely pressing such a button the selector in that particular station is operated, to the exclusion of all others, and in a few seconds the bell is ringing loudly. And, to show the completeness of this calling arrangement, the despatcher also hears in his telephone receiver the flutter of the bell and therefore knows that it is ringing. The despatcher can stop the call when he likes, and a short ring generally arouses an immediate response. But, if not, the call may be continued until the answer is received, something that does not often occur, because an excuse for not answering does not have the same weight where a bell rings loudly that it does where an instrument may be feebly ticking off the call. And if it were not enough that the time used in calling offices should be practically eliminated, there is the further advantage that these calls may be made upon the line at the same time telephonic conversation is being carried on, one operation not interfering with the other.

If the operator at the station wishes to communicate with the despatcher, he simply removes the telephone from the hook, places it to his ear, and if there is an opening for him he states the name of the station and the despatcher instantly replies by saying "Despatcher." The "reporting" of trains—that is, the stating of the time of passing or of the arrival and departure of trains at stations—is made to the despatcher much more quickly than is possible by telegraph, and, where messages are necessary, they may be transmitted by telephone with the speed at which the operator and despatcher may be able to write longhand, and with equal accuracy to the telegraph. Information regarding derailments or other trouble is conveyed to the despatcher by verbal and complete narrative, either by the station operator or the conductor of the train involved, so that the despatcher is in immediate touch with the situation, while in using the telegraph for this purpose message after message is required before there is a complete understanding of the details.

In transmitting "orders" by telephone, the despatcher spells out in full the names of stations, numbers of engines and trains, the times and the proper names involved. This, however, is done with speed and precision, and the despatcher writes the order in the record before him as he gives it, not waiting to make the record when it shall be "repeated" to him by the operator, as is done in the telegraph operation. This change in making the record of the order from a subsequent to an initial one is very important from the standpoint of absolute accuracy.

Unquestionably there are doubters still of the complete success of the telephone in train despatching and the allied services. The change—if it may come—from the use of the telegraph to the telephone in moving and making up trains, in the handling of the thousand and one details connected with the immediate motion of traffic and in giving to all the employes concerned in the work the benefit of the interchange of judgment through direct conversation, is revolutionary.

But it brings quick action where formerly it was slow. It takes from the despatcher the necessity for operating his trains through the medium of a large number of telegraph operators of varying ability. It brings to bear upon this most important of services direct conversational contact between all the interested parties, something of greater value to this particular work than can be fully described. There is harmony of action, harmony of temper, human understanding and personal relations of the most satisfactory character. There is the certainty that more movements will be better planned and executed, and that the art of direction of operation of trains will be greatly advanced and the work more safely rendered.

NEW CATALOGUES.

Bulletins G and H from the Pacific Electric & Manufacturing Co., San Francisco, are respectively devoted to oil switches and pole top switches manufactured by the company.

Westinghouse Electric & Manufacturing Company are distributing their Ad. Book No. 10 among interested central stations. This contains twelve pieces of newspaper copy advertising central station power and should form a valuable auxiliary to electrical publicity.

Reynolds Electric Flash Manufacturing Co., Chicago, Ill., have issued a series of seven bulletins and price lists telling of their products. These include flashers, whirlers, script writing flashers, revolvers, combination flashers, automatic time switches and flag flashers. They have also issued a bulletin on the Oliver Roto.

In these days of automatic railway signals the thorough testing of such signals is absolutely necessary. For this purpose the General Electric Company has designed a voltammeter which it describes in Bulletin No. 4714, recently issued. This instrument is arranged for four capacities or combinations, so that two voltage ranges and two current ranges, or three current ranges or one voltage range can be obtained. These instruments are contained in polished mahogany cases, and are portable. The bulletin contains reproductions of the scales in actual size.

LARGE RESERVE STEAM STATION.

Profiting by the misfortune of the city of Winnipeg, which has been practically in darkness for the last few months, due to the shutdown of a water power station, the public utility companies of Pacific Coast cities have been seriously considering the installation of reserve steam plants in order to protect their constituents from a possibility of such troubles as at Winnipeg. Although the management of all the companies has been giving this serious thought, the first to take definite action has been the British Columbia Electric Railway Company, Ltd. This concern owns and operates the railway systems of Victoria, New Westminster and Vancouver and is installing several interurban lines connecting all of the rich and fertile valleys around Vancouver. Its endeavor has been to give the public satisfactory service. With this in mind, as soon as the need of an up-to-date steam generating station was brought to their attention by the disaster in Winnipeg, the directors immediately took steps to protect the interests of the public in Vancouver and vicinity by the installation of an up-to-date steam generating station which will serve as an auxiliary in case of breakdown on any part of the water power system. This station with the realty holdings, dredging, etc., will represent an outlay of about $500,000.

The British Columbia Electric Railway Company recently awarded contract to the Allis-Chalmers-Bullock Company for two 2,000 kilowatt Allis-Chalmers steam turbines, with a stipulation in the contract that delivery should be made at the earliest possible date, subject to bonus and penalty. At the same time the general contract was awarded for the construction of the steam station to the well-known engineering concern of Charles C. Moore & Co., placing the contract through the Seattle office. This contract is one of the largest for machinery which has ever been placed in the Northwest, and includes Babcock & Wilcox boilers, Babcock & Wilcox chain grate stokers, Wheeler condensers, all auxiliaries, piping, foundations, flues and a reinforced concrete chimney 11 feet in diameter by 240 feet high.

The installation will be the most modern practice in engineering in connection with auxiliary steam stations, and Mr. C. R. Weymouth, the head of the engineering department of Charles C. Moore & Co., engineers, is now in the East placing orders for the machinery.

Charles C. Moore & Co.'s contract involves heavy bonus and forfeiture clause regulating the time of completion, and the installation of this plant will be made in record-breaking time. An endeavor will be made by the concern to have the 6,000 horsepower station completed and operating by May 1st. Great interest is already manifested by the engineering public as to when this plant will be ready for operation. The early date specified in the contract could only be met by a concern having the able organization possessed by Charles C. Moore & Co.

TRADE NOTES.

The General Electric Company is to be complimented upon the high class of electrically heated household appliances which were exhibited at the Alaska-Yukon-Pacific Exposition recently held in Seattle. The quality and appearance of the apparatus displayed was evidenced by the fact that they were presented with two separate and distinct grand prizes for this class of material. A misunderstanding has been prevalent as to what these two prizes included, and as a matter of information we might say that one of them applied to "cooking devices," such as the cereal cookers, broilers, ovens, toasters, percolators, etc., and the other one included "heating devices," such as the flat iron, tubular air heaters, luminous radiators, etc.

There is but one conclusion to be drawn from the above facts; that is that the General Electric Company were honored with the highest possible tribute to their product.

The Merced Falls Gas & Electric Company has purchased from the General Electric Company three O. C. 60, 150-kw., 11,000-volt primary, 2200-volt secondary, oil-cooled transformers. Also, one 2200-volt, 3-phase, 60-cycle 100-ampere, 38-kw., type 1, R. T. automatic feeder regulator and a 3-panel switchboards.

The Central Oakland Light and Power Company, A. M. Hunt, president, has completed the structural steel work on its three-story electric power station at First and Alice streets, in Oakland, where it has a ground area of 30,000 square feet. The boilers will be installed on the ground floor and the steam turbine generating sets on the second floor. The initial equipment includes two 2000 kw. Westinghouse-Parsons turbo-generators. The laying of underground conduits will be commenced during the coming week.

The Pelton Water Wheel Company's San Francisco factory is working overtime on large turbine wheels and it is expected that a night shift will soon be put on. Pelton-Francis turbines are being constructed to replace the original water wheels at the Washington Water Power Company's plant in Spokane, Wash. Additional turbine wheels are being constructed for increasing the equipment of the Pacific Light & Power Co.'s transmission plant on the Kern River. The effective head is 257 feet.

Due to fast increasing business, both the Chicago and Baltimore branches of the H. W. Johns-Manville Company have outgrown their present quarters, and about March 1st, both will move to new locations, with more room. The Chicago branch, now on Randolph street, will move to the four-story and basement building at Nos. 27-29 Michigan avenue, located in the block between South Water and River streets. With 32,500 square feet of floor space, offices, store and stock rooms will all be under one roof, with ample room for all. A full stock of J-M products will be carried, thus assuring prompt shipments. The Baltimore office, store, and warehouse will be located at No. 30 Light street. Here the company will have considerably more room than before, and will keep on hand a large stock of J-M products and will be in much better position than ever to give all orders prompt attention.

An impulse water wheel contract recently awarded the Pelton Water Wheel Company's San Francisco works consists of a 700 hp. single overhung Pelton impulse wheel, direct connected to a Westinghouse alternator. This apparatus is intended for the Hilo Electric Light Company, Hilo, Hawaii, and supplements their existing hydro-electric equipment. There is an effective head of 418 feet, giving a speed of 400 r.p.m. A special automatic nozzle is being furnished, the direct actuation of the nozzle orifice being obtained by means of a Pelton oil-pressure speed-governor. The question of water economy is of the utmost importance in this plant and as the load is extremely variable, it follows that unless the water is throttled at the impulse wheel, a considerable amount would go to waste. By the installation of the automatic nozzle, the highest possible degree of water economy will be obtained, irrespective of load changes. This will result in a greater peak output. The plant will supply current for various pumping stations on plantations adjacent to Hilo. Automatic adjustment of the nozzle mechanism for impulse units is steadily increasing in favor with engineers who are confronted with the porblem of maximum water economy. Not only are the nozzles of hydro-electric Pelton impulse units directly actuated by the governor, but Pelton wheels for driving air compressor are also equipped with this attachment. Speed regulation and efficiency is not affected by the device, neither is there any danger of water hammer, even should the entire load be instantly dropped from the wheel, because these important features have been taken care of in the peculiar design of the Pelton automatic nozzle.

NEWS NOTES

FINANCIAL.

HOOD RIVER, ORE.—Municipal bonds in the sum of $90,000 have been sold to John Nuveen & Co., a Chicago bond house, for $90,026, the money to be used in constructing the city's proposed new water system.

DRAIN, ORE.—The City Council has passed an ordinance to acquire or build a water system for the city and to issue $5,000 in bonds therefor, payable in 30 years, with interest at 5½ per cent; also an ordinance was passed to create a sewerage system, and the issue of $5,000 in bonds for that purpose was authorized.

LOS ANGELES, CAL.—Bonds to the amount of $300,000 of the Ontario and San Antonio Heights Railroad Company have been placed on the market by the Pacific Light and Power Company, which controls the road. It has just been completed and will form a link in the Huntington system of interurban trolleys, extending from Los Angeles through Southern California. The company will connect the present line at Upland, Ontario and San Antonio with the road now operated by the Pacific Electric at Pomona. This line will be in operation before June 1st. Following this the Pacific Electric Covina line from Los Angeles will be extended to Pomona, and this will be followed again by an extension to San Bernardino if rights of way can be secured.

INCORPORATIONS.

PORTLAND, ORE.—The Oregon Water Power and Land Company, with a capital stock of $100,000, has been incorporated by Charles Stout, G. A. Johnson and J. R. Hollister.

LOS ANGELES, CAL.—Mont-Antonio Water Company, with a capital stock of $75,000, has been incorporated by Alex Kirkpatrick, F. M. and Lydia A. Dyke, Ira J. and Ella Cree.

CENTERVILLE, WASH.—The Centerville Telephone Company of Centerville, Wash., with a capital stock of $5,000, has been incorporated by Henry Garnor, Theodore Jackel and Henry Jackel.

SAN FRANCISCO, CAL.—Tuolumne River Power and Irrigation Company, with a capital stock of $50,000, was incorporated by D. A. Jones, G. W. Barnett, C. W. Terry, T. F. McGovern and C. H. Segerstrom.

SPOKANE, WASH.—The Commonwealth Power and Water Company of Spokane, with capital stock of $5,000,000, has been incorporated by J. E. Burns, E. F. Waggoner, F. W. Dewart, L. H. Brown and Carl Ultes.

TRANSMISSION.

HUSUM, WASH.—The Husum Power Company will enlarge its plant soon.

NORTH YAKIMA, WASH.—E. T. Stone has filed on 5,000 cubic feet per second of water in the Yakima river for power and manufacturing purposes.

SEATTLE, WASH. — Thomas-Jacobsen, Inc., capital $1,000,000; B. Thomas, John P. Jacobsen and S. S. Langland, 534 New York Block, will develop water power in the State.

TUCSON, ARIZ.—The Great Western Power Company has presented to Tucson City Council details of a project for developing about 250 horsepower in Sabino Canon in Catalina Mountains, 18 miles from here, where the company proposes to spend $1,500,000 in necessary storage and power works.

SPOKANE, WASH.—The Washington Water Power Company is considering plans for developing 40,000 horsepower by sinking a shaft from the crest of the upper falls and tunneling to the present plant or by the construction of a dam and pipe line. Either plan will cost about $1,000,000.

CECILO, ORE.—Portland capitalists have recently purchased 80 acres from I. H. Taffo and propose to build a town. Portlanders are J. W. Grussi, O. L. Daggett, A. L. Holst, Charles M. Zadow, Frank A. Jeffrey and Frank U. Jones, and compose the Celilo Milling and Power Company. The contract stipulates that the power company is to erect a power plant on the premises, and while it is not stated for what the plant will be used, it is supposed that electric power will be generated here for the use of railroads, flour mills, etc.

SEATTLE, WASH.—As an integral part of the merger of eight separate electric power, railroad, light and irrigation companies in Central and Western Washington, covering more than 50 per cent of the available hydro-electric power resources of the State subject to private development, Robert E. Strahorn has closed the deal in this city for the purchase of the water rights and surveys of the Columbia Development Company for $100,000. Involved in the deal is the construction of a hydro-electric power plant, with a rated capacity, after full development, of more than 60,000 horsepower.

FRESNO, CAL.—The work now being done by the San Joaquin Light and Power Company in the hills about North Fork and Crane Valley will be practically finished by August 1st. The dam at Crane Valley is to be completed about that date, and it is expected that all the rest of the work will be finished before the dam is in. The wagon road from North Fork to power house No. 1 is on an 8 per cent grade and covers the same ground formerly traversed by a road which was almost bad for a pack train. Motors for the new cars which the traction company will have here about the first of the company month, arrived last week. There are 20 of these motors, with controllers, etc. These ten new cars are now in the paint shop, and it is not definitely known just when they will be shipped. Contracts have been signed by the traction company for a new 400 kilowatt motor generator, to be used in the operation of the street car system. It will cost $15,000 and will generate enough power to drive all of the present cars. It will be here in about two months, and will be used as an auxiliary to the local plant to forestall danger of complete breakdowns. Poles are now up on the new Coalinga-Lemoore power line except over a space of about ten miles southwest of Huron. It is expected that poles will be set in the next few days.

TRANSPORTATION.

KENT, WASH.—The Valley Railway and Power Company has been granted a 35-year franchise for a street railway system here.

ABERDEEN, WASH.—C. C. Quackenbush of this city is promoting a project of building an interurban from this place to Seattle, a distance of 87 miles.

BUTTE, MONT.—It is reported that the Montana Rapid Transit Company has been financed and will build its proposed line between Helena and this place.

SALT LAKE CITY, UTAH.—A petition has been submitted by E. O. Howard for a franchise to construct tracks over certain streets in the city for an interurban road to be built from Salt Lake to Provo.

BELLINGHAM, WASH.—This place has completed the $400,000 guarantee fund to insure the building of an interurban electric line between this and Skagit county cities. Stone & Webster will construct the line.

SAN FRANCISCO, CAL.—A resolution has been introduced calling on the Board of Public Works to have prepared by the Bureau of Engineering plans and estimates for reconstructing and extending the Geary street railway.

SEATTLE, WASH.—A franchise for the privilege of operating a railway service from Kent to Renton will be placed before the City Council by the Valley Railway and Power Company, of which H. B. Madison of Kent is the president.

EL PASO, TEXAS.—The El Paso and El Paso Valley line will not have an interurban electric line this spring. The reason of this action is that some of the benefactors failed to join in the co-operative movement to furnish rapid transit to El Paso Valley.

SAN FRANCISCO, CAL.—The Vallejo and Northern Railroad Company has been granted a 50-year franchise. The new franchise covers the same privileges granted the company two years ago, and provides that the franchise work is to be commenced within six months and the road completed within three years.

SACRAMENTO, CAL.—At the Trustee's meeting all the requests of the Judicial Committee in the matter of the application of the Sacramento Electric, Gas and Railway Company, for a franchise on Y street from Tenth to the Riverside road, were complied with and the franchise was ordered advertised.

FRESNO, CAL.—Manager A. G. Wishon of the Fresno Traction Company states that work on double-tracking of the system in this city has gone no further recently than the distribution of rails along rights of way. Work on the Coalinga-Lemoore power line has progressed as far as the placing of the cross-arms.

POMONA, CAL.—The Pacific Electric Railway will construct a single track line along West Second street within 30 days. The company has asked for a new franchise down Garey to Franklin avenue and for a franchise on Fifth avenue from Garey eastward to the city limits. These latter tracks will be finished in six months.

ILLUMINATION.

MEXICO CITY, MEX.—Don Pedro Flores of Tasco, in the State of Guerrero, has ordered from the Allis-Chalmers Company a complete electric lighting plant, which will be installed at Tasco.

COTTAGE GROVE, ORE.—The Cottage Grove Light Company, having been granted a five-year contract for light in the city, will at once begin the improvement of its plant and will install a 600 horsepower engine.

TACOMA, WASH.—The commissioner of Public Works is authorized to enter into a contract with the United States Incandescent Lamp Company for the purchase and delivery of incandescent electric lamps to the value of $25,000.

SPOKANE, WASH.—H. L. Moody, president of the Spokane Railway and Power Company, states that the company has selected a site at Le Pray bridge, on the Spokane river, and is preparing to spend $1,500,000 on an electric lighting plant there.

COLUSA, CAL.—The Pacific Gas and Electric Company is contemplating improvements for the town of Colusa. They are at present remodeling their plant at Second and Main streets, where they will put in new boilers, two new pumps, two purifiers and lamp black separators.

GEORGETOWN, WASH.—The City Council has passed an ordinance authorizing Robert M. Jones to erect gas, electric light and power works, to lay pipes for the distribution of heating and illuminating gas and to construct apparatus for an underground electrical system in Georgetown.

POMONA, CAL.—The Southern California Edison Company is planning large extensions to its gas mains and equipment for service here. Lately an active business has been done in laying service mains and lines to new subdivisions about the city. In the southern part of the valley much extension work is being done along the electric lines, and many new motors have been installed for the running of the pumping plants.

SEATTLE, WASH.—The Othello Improvement Company has awarded a contract to the Northwest Bridge Company for the construction at Othello of a power house, to furnish electric light and power for the city, at a cost of $17,000. Arrangements have also been made with the same company for installing a street lighting system and for laying 116,000 square feet of cement walks, and also for the erection of a factory, details of which are to be agreed upon later.

SUISUN, CAL.—Benj. F. Rush, Senator from Solano and Napa counties, has started a crusade against the electric light companies operating in the various cities and towns throughout his district. Senator Rush has announced that if the present corporation laws of the State are not adequate in bringing the public concerns to time, he will introduce at the next session of the Legislature such bills as will permit municipalities to so control the fixing of light, power and other rates as to prevent the extorting of unreasonable tolls by the corporations.

TELEPHONE AND TELEGRAPH.

AUBURN, CAL.—Manager Bryson has been authorized to build a telephone line from Alta to the Rawhide mine.

HAINES, ALASKA.—The Arctic Development Company was granted a franchise to construct and operate a telephone system here.

COUPEVILLE, WASH.—The Utsalady Telephone Association was recently granted a franchise for a telephone line along certain roads.

NORTH YAKIMA, WASH.—All bids for constructing the west side drain were rejected as being too high, $33,000 being the amount available for this purpose.

SPOKANE, WASH.—Local and Long Distance Telephone Company will extend the lines to the Coast this year, announces Manager L. V. Gray, Lindelle Block.

BAKERSFIELD, CAL.—The Producers' Transportation Company has been granted permission to construct private telephone and telegraph lines along their pipe line between here and McKittrick and Midway.

OAKLAND, CAL.—The redistricting and renumbering of telephones in the newly annexed districts of Oakland has been completed by the Pacific Telephone and Telegraph Company, and all telephone subscribers in the district east of Jackson street are listed on the newly completed Elmhurst exchange on East Fourteenth street in the Fitchburg district. The old arrangement whereby telephones as far out as Elmhurst were listed on the Meritt exchange has been done away with and that exchange will extend only as far east as Jackson street. The fight between the telephone company and residents of Elmhurst over telephone rates may have its solution in the threat of several business men of that district to take the matter before the City Council. As Elmhurst is a part of the city now, it is contended that residents there are entitled to the same service at the same price as other parts of the city.

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POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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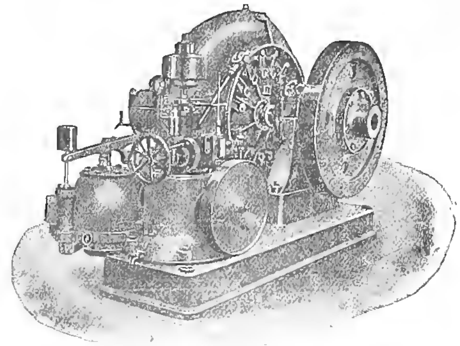

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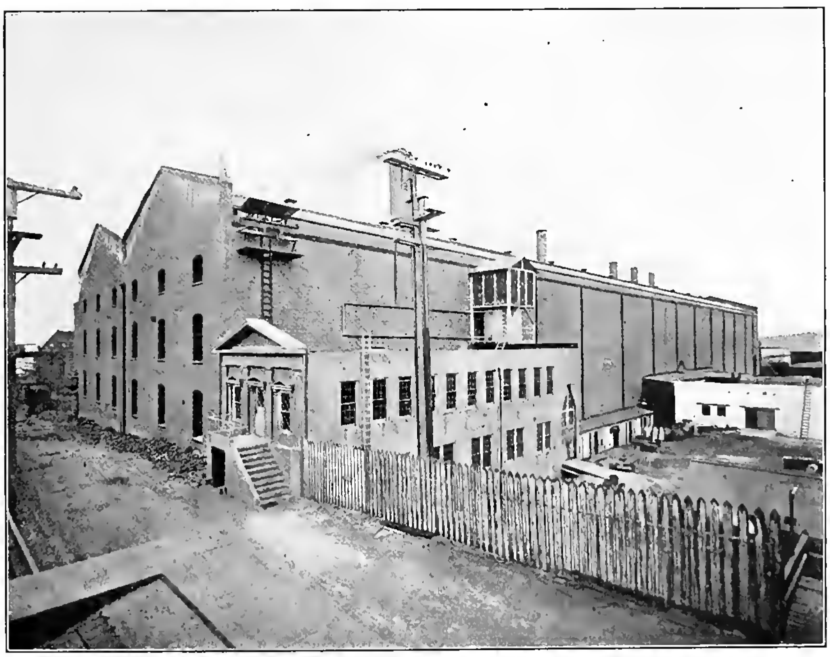
STATION A, SAN FRANCISCO

BY EDWARD STEPHENSON.

Edward Stephenson

Out beyond the Union Iron Works, in the Potrero district, is a huge steam-driven plant that generates much of the electric light and power used in the city and county of San Francisco. The east wall of the building adjoins the great Spreckels Sugar Refinery, because when this electric plant was established about ten years ago it was owned by Claus Spreckels, who also owned the substantially rock-ribbed shore land on which it stands. The natural solidity of the site accounts for the splendid manner in which the building and its foundations have stood earthquake tremors and the constant vibrations of the massive machinery. As there are eleven water-driven and eight steam-driven electric plants in the system controlled by the Pacific Gas and Electric Company this generating plant is designated as Station A.



Station A, San Francisco.

In size and output it is one of the largest plants of its kind west of Chicago, and it requires the expert services of one hundred men to operate its machinery.

The building is an immense brick structure extending from street to street through a city block. It is 450 ft. long, 140 ft. wide, and 80 ft. from its fireroom floor to its steel-ribbed roof of galvanized sheet-iron. A division wall runs the entire length of the building and makes of it two big rooms of equal size.

The long room on the east side of this double building (the left-hand side in the picture) contains the twenty-seven steam boilers, the six boiler-feed pumps, the one salt-water fire-pumps, the five economizers, the three auxiliary exhaust feed-water heaters, the four fuel-oil pumps, the five fuel-oil heaters, and all the steam and water piping necessary to the operation of this big modern boiler plant, which has six smoke stacks and four induced-draught fans to accelerate the draft in the boilers and economizers. The long room at the west side is the engineroom, and it also contains thirteen electric generators. Ten of the generators can supply San Francisco with all the electric light and power the city ordinarily uses.

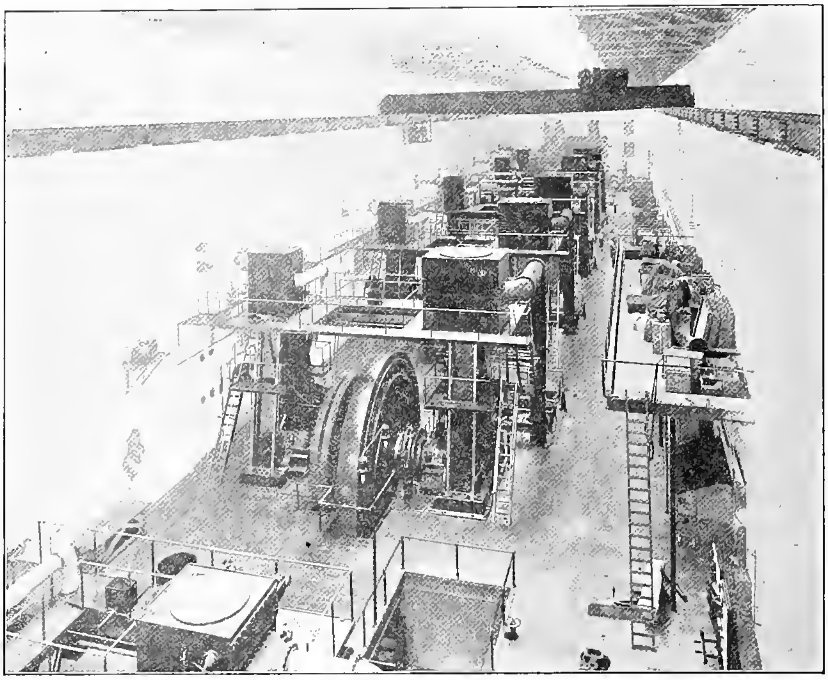
Three of the generators are used to supply the exciting current to run the ten others. The foundations for these big generators are built up 15 ft. above the main floor, and on a level with the tops of these generator foundations is the floor of the engineroom. On the main floor, which is below the level of the gen-

erators and the engineroom, are installed all the condensers, air-pumps, pipes and such other equipment as can be placed below the engineroom floor.

Before the plant was finished it was sold by Claus Spreckels to the San Francisco Gas and Electric Company, and then the installation was completed.

The accompanying view of the outside of the building conveys a very good idea of its massive construction and size.

The boilers in this building are capable of daily converting 2,000,000 gallons of water into steam at a pressure of 200 pounds to the square inch. About thirty miles of four-inch boiler tubes are contained in the boilers and economizers. It is not often that the maximum capacity of the plant is needed, yet in winter time, during the period of short and dark days, it is quite usual to evaporate 5000 tons of water a day and convert it into steam. The production of steam is the first step in a steam plant's generation of electric light and power.

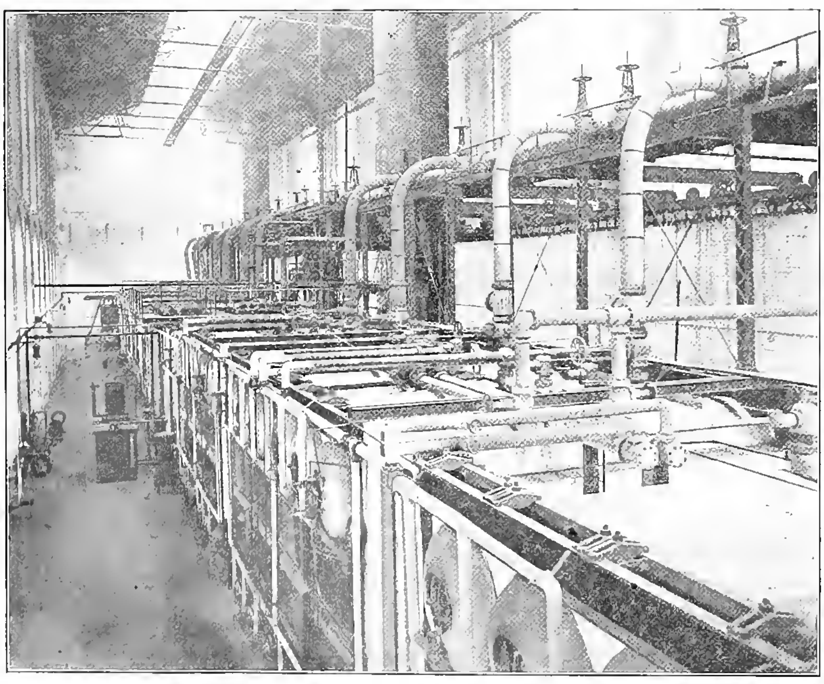


View of the Engine Room, Looking South.

To change 5,000 tons of water every twenty-four hours into steam at 200 pounds pressure requires an enormous amount of fuel. So much fuel is needed that if coal were used this great plant in itself would consume more coal every day than it now daily used in the entire city of San Francisco. But fortunately the fuel is crude-oil.

This plant uses 100,000 gallons of fuel-oil a day. But to handle this immense amount of oil happens to be about the easiest and simplest work about the station. Of course fuel-oil cannot be left round like coal. Elaborate containing tanks must be provided. They must be of a size sufficient to store a large reserve supply to protect the plant against the risks of delayed delivery.

Sometimes the railroad company cannot get the oil-tank cars through from the wells. Sometimes the oil-carrying steamers are delayed. Sometimes the cross-country oil-pipe lines burst or need repairs. But despite any or all of these uncertainties, Station A must keep going and keep giving to the people of San Francisco all the electric light and power they require.



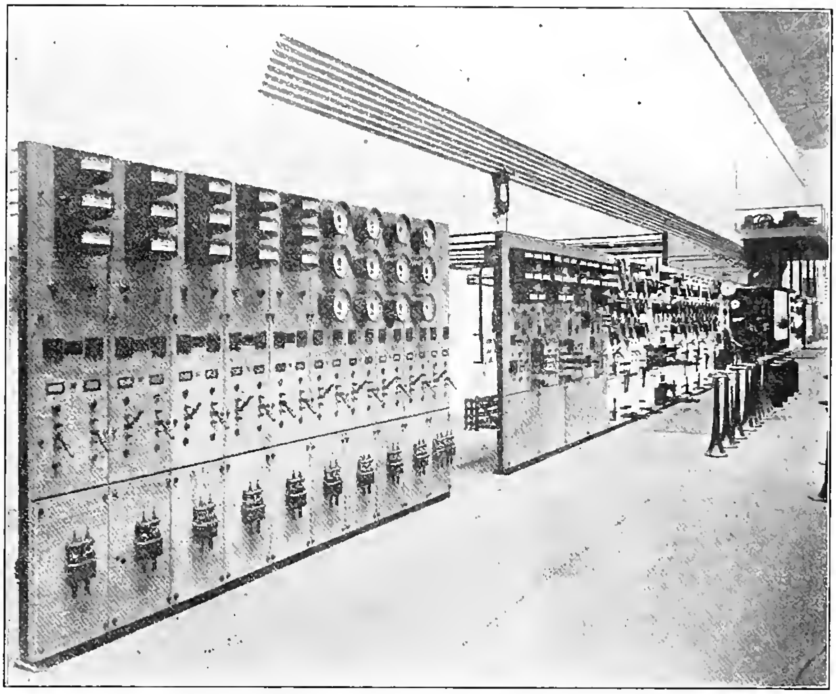
View of the Boiler Room, Looking South.

The forethought of the company management in supplying such ample storage capacity at Station A. has averted shut-downs. When the oil company has been short of oil the large reserve storage at Station A has given it a a place from which to secure a temporary supply.

Steamships carrying 50,000 barrels, or 8,000 tons, of fuel oil can come alongside the company's own wharf near its plant and discharge their oil cargoes directly into the storage tanks in about fifty hours. As there are two separate pipe lines the oil cargo from two oil-boats can be pumped out at the same time. Probably no other electric light and power plant in the world can handle

its fuel in such large quantities and so quickly as can station A. Fifty thousand barrels, or 8,000 tons, of oil can be received at one time in oil cars on the plant's own spur tracks, but the operation of pumping out the tank cars is slower than the pumping of the same amount of oil from the ships.

After the production of steam the next step in the making of electricity at Station A is the use of this steam to run the electric generators. Reciprocating engines are used to revolve the generators. Six of these engines are of the McIntosh and Seymour standard compound type of 2,200 h.p. capacity at normal load, two are of the Union Iron Works type and design similar to those used on the latest American battleships built by the Union Iron Works. These last two engines were rated by the Union Iron Works at 4,800 h.p., but even after years of use the normal capacity of these two engines when working with the greatest ease and smoothness is about 6,300 h.p., or more than 31 per cent greater than the makers guaranteed.



Stationary Switchboard in the Engine Room.

Every engine is supplied with condensers and air-pumps which are intended to receive and condense into water all the exhaust steam from the engines. This distilled water is then pumped back again into the boilers. Thus the cycle is maintained; the water condensed into steam, the exhaust steam converted again into water, and this water sent back into the boilers to be reconverted into steam, the endless round being maintained as long as the plant is operating.

Some idea of the length of time this operation has been unceasingly continued may be gained from the explanation that some of the engines have revolved more than 500,000,000 times since they were first installed.

In changing the exhaust steam from these engines back into water it is necessary to cool the steam until its latent heat has been abstracted. This cooling operation requires the use every day of about 75,000,000 gallons of salt-water. That is twice as much water as the Spring Valley Water Company daily supplies to the entire city of San Francisco. To put it another way, Station A has to pump 150 gallons of water a day for each of the 450,000 people in San Francisco in order that the whole city may have the electric light and electric power it needs.

The work of raising this salt-water requires four centrifugal pumps driven by electric motors. These four pumps are housed near the waterfront, about 1,000 ft. east of Station A. The salt-water comes in from the bay 500 ft. through a canal that is about 50 ft. wide at the bay end and 20 ft. wide at the pump end. The pumps are of the Byron Jackson type, and they work under a head of 50 ft. Three of them have a capacity of 30,000 gallons a minute, and the fourth has a capacity of 20,000 gallons a minute. They all discharge into a great thirty-inch cast-iron main, extending 1,000 feet to the electric plant. After this pipe reaches the station it has outlets at each condenser, at each cooler, and at any other places where salt-water may be required. Each outlet is provided with strainers of a standard pattern to intercept any dirt that may have passed the primary strainers at the suction end of each pump in the channel.

To keep all this system of machinery in repair and running smoothly requires the services of one hundred men, each an expert in his particular line. And when each man does his work well and gives full vent to his knowledge of the subject, then Station A is entirely successful; and I am proud to say that this condition has been generally maintained. It is creditable to the men themselves that the efficiency at Station A is much higher as the years go by and the plant and the machinery grow older. This higher efficiency is due to the systematic way in which the men at this plant pull together and observe the rule that "a stitch in time saves nine." They not only put in the timely stitch, but, if the place be thin, they put on a patch in time and make things more secure. And the end is not yet, even after Station A has generated more than 500,000,000 kilowatt hours. She is still a big, sturdy, reliable producer of electric energy, because the men and the machinery keep working smoothly.

The United States Civil Service Commission announces an examination on March 29, 30, 31, 1910, to fill eight vacancies in the position of skilled draftsman, at salaries ranging from $900 to $1,200 per annum, in the office of the Chief of Ordnance.

WATER SUPPLY AND TREATMENT FOR POWER PLANT PURPOSES[1].

BY WILLIAM MILLER BOOTH.

The price of raw material, of fuel, labor conditions and freight rates are important factors to be considered when a new industrial plant is to be built. Less often investigated, yet of primary importance is the presence of a constant supply of good water. If possible two independent sources should be made available. It is not a large manufacturing concern that requires boilers of 1,000 h.p. capacity. If run 10 hours per day these evaporate approximately 170 tons of water. When condensing engines or turbines are used, from 14 to 17 times as much water is necessary to return the steam again to its original state, or about 2,500 additional tons—in the aggregate more than 9,000 pounds per minute.

The quality of the water is not a matter of indifference, as modern power house apparatus makes exacting demands of the medium passing through and over its parts. It will readily be seen that choice of water requires knowledge of power plant conditions and should not be handled in a haphazard way. While our population and manufacturing interests constantly increase, available water is decreasing, especially in our small streams that flow through densely settled districts.

Given two sources, the use of that which entails the least cost is naturally considered—the quality is often neglected. Unfortunately water exactly adapted to boiler use is seldom found in nature. For convenience we classify waters as follows:

AVAILABLE SUPPLIES

Class—Source.	Contain	Action in Boilers.
Soft—		
Rain and snow water from granite	Ammonia Salts	Corrosive
Returned	Alkali	Negative
Swamps	Ammonia	Corrode
Lakes	Organic matter	Corrode
Large rivers	Calcium and Magnesium Salts	Slight scale
Hard—		
Springs	Lime, magnesia, iron	
Lakes	Sulphates	Scale forming
Small Rivers and Creeks	Chlorides	
Wells	Carbonates	
Saline—		
Sea		
Well	Lime, magnesia,	
Mineral Springs	Sulphates, Chlorides and Carbonates, Sodium and Potassium	Scale forming Corrosive Foam
Alkaline—		
Streams from Western Plains	Sodium, Chlorides, Sulphates and carbonates,	Foam
Springs	Silica, Lime, Magnesia	
Acid—		
Mineral Springs	Hydrogen	
Wells	Sulphide	Corrode
Coal Regions	Iron Sulphate Sulphuric acid	

Soft Water.

The first group includes rain and snow waters that are free from scale-forming materials, but which contain organic matter and in the first instance may have a strong acid reaction. The use of such waters is attended with danger from pitting. Harder water should always be mixed with these, or a slight excess of alkali may be added.

Precipitated waters flowing over granite rocks are ideal for boiler use, as enough alkali is absorbed to prevent pitting. Water from wells, driven in granite and quartz sand to a depth of sixty feet, has been found to possess a hardness varying from .5 to 2 degrees Clark—pure water being unity.

The only distilled water practicable for boiler purposes is that returned from vacuum pans, pumps, engines, turbines, surface condensers and heating systems. Condensed water from turbines containing no oil ought to be ideal for boiler use. We have, however, had an instance of severe corrosion resulting from the use of such water with a proportion of fresh hard water added at each return to the boilers. Returned turbine water should be made slightly alkaline. We believe that the open heater and hot well should be much more generally used and that a good oil separator is indispensable in any large plant. Anxious to keep his apparatus well lubricated the engineer often uses an excess of oil which makes it difficult to utilize the condensed water. A large amount of energy escapes daily from many plants through heated water that runs to waste, in addition to the loss of soft, scale-free boiler water. Many engineers suffer from oil at the surface of the water in the boiler; the gauge glass showing this condition quickly. If mineral oil is used in the power plant we do not worry about the presence of a small quantity in the boiler, but prefer to keep it out.

Another class of soft waters is found in the lowlands of the coast. A heavy rainfall with finely divided organic matter and heat, combine to charge standing water with organic matter which may be acid in character. Boilers using such water suffer from corrosion and require alkali.

The waters of some lakes, large rivers and a few deep wells deposit little scale and may be termed "soft." Arbitrarily we fix the hardness under 3° Clark. Such waters contain suspended particles, sand, clay, leaves and dissolved organic matter, the quantity of these varying greatly during different seasons. These require considerable blowing down at the boiler. Water of this character is improved by sedimentation in large tanks followed by upward filtration through coarse material, as sand, coke breese or excelsior.

We insist that water for boiler purposes shall be clean. Sewage laden lake or river water carries grease which accumulates upon the headers of water tube boilers and corrodes the tubes and shells of tubular boilers. Our clients are much annoyed by such water. We recommend sedimentation, upward filtration and legal proceedings against the corporation or individual contaminating the stream. This applies particularly to abattoirs, rendering plants, woolen mills and cities. As a last resort we recommend chemical precipitation and filtration.

Hard Waters.

A large proportion of our water supply is scale forming. If ten grains of this material per gallon are present nearly 140 pounds of sludge and scale will concentrate, in a 24-hour, 1,000 h.p. plant. This interferes

[1]Abstract of paper presented at the Twenty-Ninth Annual Convention of the American Water Works Association.

with the operation of the boiler as a steam producer. In many samples of water, carbonates vary from 3 to 15 grains per gallon and sulphates from a trace to 120 grains per gallon. What these compounds are and how they are formed will not be discussed here.

Organically pure but hard sources of supply are used by many cities and towns to the disadvantage of manufacturers. We have suggested in a previous paper that large operators should combine to manufacture soft water for their common use. Water companies might soften supplies furnished certain districts. We believe that scale-free, clean water is worth 10 cents per 1,000 gallons. It usually costs less than 3 cents to soften this.

Many manufacturers drill deep wells to provide drinking water and to serve as an auxiliary supply. We suggest consultation with a practical geologist before putting a large amount of money into such an enterprise.

Having been fortunate enough to obtain water this may be of any class mentioned in the table. For power plant purposes heavily charged mineral waters are to be avoided. Calcium and magnesium carbonates and calcium sulphate are scale producers. Chloride of magnesium corrodes metal and sodium chloride accumulates on all semi-heated surfaces. For boiler purposes we have not been troubled by the precipitation of iron found in natural waters. If water from a well contains all of these forms of impurity in any considerable quantity it should not be used for power purposes.

Those who drill wells should take samples of the strata and water encountered. Analysis of these will show what veins of the supply are to be avoided and cased out.

Saline Waters.

Few waters are free from chlorides. Common salt is not considered scale forming, although large quantities are not easily handled, while the chlorides of calcium and magnesium are very objectionable in a boiler. We have no remedy to offer for heavily charged saline waters. Evaporation results in choking boilers and condensers.

Alkaline Waters.

Some waters contain carbonate, chloride and sulphate of soda and potash with perhaps chlorides of calcium and magnesium.

This is particularly true of waters of the western plains and lakes. As an extreme instance we submit the following analysis of a water sent us from a California lake:

GRAINS PER U. S. GALLON.

Silica	14.35
Alumina	trace
Oxide of iron	.00
Calcium carbonate	trace
Magnesium carbonate	.00
Potassium chloride	93.56
Sodium chloride	2,754.30
Sodium sulphate	610.50
Sodium carbonate	2,573.10
Acid carbonate of soda	248.50

This is a representative of very bad alkali water, which could not be used for technical purposes. If a boiler is clean we find it almost impossible by adding alkali to produce foaming. This has been proved with an excess of soda ash amounting to 50 grains per gallon.

Acid Waters.

Water from expensive wells sometimes tastes and smells of hydrogen sulphide. If at all strong engineers will usually not allow such water in their boilers. We believe that, should circumstances warrant the outlay, a heavily charged sulphur water could be successfully prepared for boiler or other industrial use.

Water from the mining districts often contains sulphate of iron. We consider this dangerous water and suggest treatment before use.

Some waters contain free sulphuric acid. Sometimes such water is supplied naturally, but generally this is found in sludge from acid plants, coal washers or refineries. No more dangerous material can find its way into the boiler.

A sample of scale from boilers in a Pennsylvania steel works was practically pure oxide of iron, the result of an acid supply.

We devote the remainder of this article to methods of handling scale-forming, saline and alkaline waters.

Three principal uses of boilers afford a natural division as follows: Marine, locomotive, stationary.

Marine boilers are generally supplied on coastwise steamers, tugs and harbor craft with soft water that is obtained at one of the ports at which the vessel touches. As many of the engine cylinders are run without oil, the returned water is used again. Trans-Atlantic steamships are supplied with surface condensers and complete distilling outfits of expensive design and the softened water is used again.

Locomotive boilers represent an enormous horsepower and need the best water obtainable. Hard water only can be found on many lines. Sometimes a soft supply is found at one end of a division and hard water at the other. Alternate use keeps the boiler free from scale. Starting and stopping and generally in motion, the alkaline content of a locomotive boiler water must be kept low. With sludge, serious foaming may result through the use of an excess of softening agent. This subject demands immediate attention on the part of all railroads. Western systems have done more in this respect than those in the east.

Our experience with stationary boilers has been divided between shell and water tube types. Methods of water treatment apply in a general way to either, although many disadvantages of hard and muddy water are overcome in water tube boilers.

Engineers in charge of steam plants are usually ignorant of the principles of water purification. This is only partially their fault, as literature for their education has only recently been available. There are many plants the boilers of which cannot be operated a single week without a deposit of scale serious in character and quantity. The most easily procured remedy has been the "compound" furnished at an inflated cost. The introduction of the softening plant has widely advertised the fact that lime, soda ash, caustic soda and tri-sodium phosphate are cheap and efficient scale removers. Many an engineer spends the Sabbath day hammering scale only to repeat the operation the Sunday following. This is usually unnecessary, as proper chemical treatment will remove the scale formed and prevent the deposit of more.

The actual cost during the past seven months to

keep boilers clean in a 2,000 h.p., 24-hour plant has been less than $15, the hardness of the water being 5° Clark. Caustic soda and soda ash have been used in slight excess.

Ideal conditions favor the installation of a standard softening system. We feel, however, that prejudice is so great that it will take at least five years to make these plants popular with engineers, who have in many instances received gratuities from compound salesmen, or with managers who cannot see an adequate return for the investment.

We now turn to methods of treatment.

While waiting for a better understanding of the correct thing to do when annoyed by hard water we have adopted the following method, which is now used in many plants. Analysis is made of the water supply or supplies; of the water from the heater, from each boiler and from the hot well. In this way we find remarkable conditions. The hardest water that has come to our notice was taken from three water tube boilers: 1, 43° Clark; 2, 85° Clark; 3, 382° Clark.

It is not unusual to find alkalies and scale-forming ingredients concentrated in the boiler water. If the supply has a hardness of 10° Clark, the internal water may have a hardness of 20, 30 or even 40 degrees.

Great stress has been laid on the removal of carbonates by heaters. We find carbonates in most boiler waters and believe that the best heaters may remove 50 to 75 per cent of these. The water circulates too rapidly to favor their deposit and the dissolved gases are occluded under pressure. The concentration of chemical salts in the presence of organic matter may cause serious corrosion. We believe that sulphates of calcium and magnesium may produce or aid in producing the holes that are eaten in feed pipes and flues, heretofore credited to chloride of magnesium, but which we find may occur when none of this chemical is present. Further investigation must be made to determine the exact cause of the foregoing results.

Having proved the presence of concentrated salts in a set of boilers, we suggest to the engineer that he shall "blow down" once in four hours or two or three times per day from one-half to two inches of water. This form of treatment some engineers will not adopt, stating that it will strain their boilers to blow them under full steam pressure; others do this regularly. We have a plant of this kind in mind where there are two 200 h.p. shell boilers that have been blown down under full head of steam perhaps two inches each afternoon for four years with no injurious results.

The scale-forming materials separate in the boiler, the decomposing carbonates rising to the top and forming a light scum, which accumulates on the upper tubes, while the sulphates and precipitating carbonates form a dense, heavy scale on the shell and lower tubes of the boiler. We believe that it is a very good plan to blow out the accumulated sediment in the morning and in the evening, and that considerable scale may be removed from the water surface while the boiler is under full steam pressure, by opening suitable cocks.

Boilers are set in peculiar ways either accidentally or through ignorance. We have found boilers with the blow-off at the rear no less than four inches higher than the floor of the boiler at the front. In some boilers the blow-off is found three or four inches above the lowest point of the shell, and we find engineers who blow their boilers but once per week, putting in from one to five gallons of compound Monday morning, and making this last the entire week, blowing it out at the close of the working day Saturday. Severe scaling or severe corrosion may result from the lack of use of the blow-off valves. If we are running a boiler or a battery of boilers using hard water, we would use the blow-off at least three times during the 24 hours. Lack of attention regarding falling scale and accumulating sludge may result in a bad bag or blister of the crown sheet.

The Prescription.

If the engineer finds that he cannot handle the sludge through the blow-off valve (and this the chemist can determine usually in advance), a mixture of alkali should be used in the boiler. This is added with the feed water drop by drop. The quantity bears but little relation to that prescribed for the same water in a water softening outfit. For instance, the prescription may call for five pounds of soda ash and two pounds of caustic soda per thousand gallons of raw water. If this is placed in the boiler in exact proportion to the number of thousand gallons used the chances are that very severe foaming will result during the coming three days. We prefer to divide the prescription by at least five and then test samples of water taken from the boilers under treatment, making a careful analysis of such treated water. In this way we are able to determine the quantity and amount of chemicals absorbed and those left in solution, also the quantity and amount of scaling material removed, and that left in the water.

The scale that accumulates on the tubes and shell is often useful in determining the kind of treatment that a boiler needs, but this scale may differ materially in composition at different points in the boiler.

The use of boiler compounds containing tannin is determined by black scale which is a dye formed by the union of tannin and iron at the expense of the boiler itself. We discourage the use of such compounds.

Objections are raised by some engineers to the use of soda ash in boilers. We have yet to find a single instance where soda ash is used in moderate quantities—even to 50 grains per gallon in excess—has injured a boiler shell or tubes, and would much prefer the use of a small quantity of this material in a boiler water to the use of rain or distilled water, both of which have a highly corrosive effect on iron. Again, some engineers state that soda ash injures gaskets. During two seasons we have tried this out in a 2,000 h.p. plant where the steam is used for heating houses and office buildings, and although expensive and complicated steam traps, meters, and gaskets are used throughout the system, we have failed to experience any difficulty whatever from this method of treatment.

Having reckoned the amount of caustic lime required to remove carbonates from the water for internal treatment we use a fraction of its equivalent of caustic soda. With carbonic acid this material is changed to sodium carbonate and if sulphates are present a second reaction takes place. A much smaller proportion of soda ash is required than when lime and soda ash are used.

On account of this double action, we believe that caustic soda should be used much more generally in water, as it is more easily handled than lime and as, further, a concentrated solution can be made. After the preparation has been applied and an analysis of the water has been made, it is not difficult to see what changes are necessary. These should be applied at once. Any form of exact treatment for boiler water within or without the boiler, demands the services of an experienced chemist and an interested engineer. An excellent water softening apparatus failed because the engineer in charge would not give it fair treatment.

Those in charge of power plants are usually anxious to learn some of the principles involved in water purification. It has been our practice to supply a regular outfit for their use. This includes the following: 1 glass burette—funnel and filter papers, 1 bottle phenolphthalein solution, 1 bottle methyl orange solution, 1 bottle silver nitrate solution, 1 quart of soap solution with the formula for making up more, and sometimes a bottle of standard decinormal hydrochloric acid. This apparatus is purchased by the power plant owner, and placed in the engine room. We have been told by one engineer that he would not take one hundred dollars for the little kit of tools provided to determine the processes going on in the boiler water. The number of tests that these men will make and the care and accuracy exercised in making them are surprising.

Water Softening Plants.

As there are now several forms of water softening apparatus on the market that are entirely efficient, the power plant manager and operator have no excuse for using a scale-charged water. With a thousand horsepower or a larger plant and with water about 10° in hardness, a water softening outfit can be shown to be an investment paying more than 10 per cent on its cost and operating expenses. In some instances this percentage may be raised to a point where the whole apparatus will pay for itself within two or three years. There is great prejudice on the part of engineers to the use of softened water, and we have found men who have put in expensive plants of this sort who are not operating them. The reason being that "they're too much bother."

Considering the cost of extra fuel, flues, the cost of opening the boilers, removing scale and poor steaming capacity, a scale-free water is a valuable investment. We find plants that are operating with boilers that have not been opened for months, and that are found in a scale-free conditions, the water being of a hardness of about 20° Clark per U. S. gallon. Originally we were not sure of the action of caustic lime and soda ash on concrete tanks, but believe that with a carefully constructed tank of this kind no danger whatever will result through the action of the alkali on the cement mass. A tank has been in use for this purpose for three years and is still in first-class condition.

The ideal chemical for softening water is not now available. Calcium, magnesium and the sulphate radical should be removed. Excessive foaming would be avoided and softened water would approximate distilled water in purity.

FUEL OIL.

BY R. F. CHEVALIER.

The various engineering magazines have from time to time treated with the subject of boiler economy, and in the last year have laid particular stress upon flue gas analyses in connection therewith. All of the articles, or rather all that have come to the writer's notice, have treated on this subject where the fuel used was coal. The reason for this is apparent. It is only within recent years that oil as a fuel has been used to any extent, and then only locally.

The quantity and grade of the oil produced in California required other means for its consumption than the refineries. Large quantities are produced that have no value except as fuel. This led to the gradual use of oil fuel, the advantages of which were so apparent and the saving effected over coal so large, that when the supply was assured, it was rapidly adopted as the main fuel on the Pacific Coast.

At first the decrease in the fuel bill was so marked that very little, if any, attention was paid to economy. Since the price of oil has increased, more attention is paid to its economical burning. Many types of burners have been invented to perfect atomization and minimize the amount of steam or air required to do the work. Various forms of furnace construction and draft arrangements have been tried with more or less success.

Summing up the practice of burning oil as fuel today, it develops that the method of handling and of combustion has not yet been thoroughly mastered. Boilers have been and continue to be fitted for the use of solid fuel, and the discarding of this practice does not seem an easy process. Designers and builders of boilers apparently are not able to thrust aside the methods used in baffling, size of gas passages and numerous other details for burning coal.

The furnace arrangements are not as efficient as they will no doubt become. The conditions under which the fuel should be burned are not yet thoroughly understood. The firing of oil seems a simple matter, yet its economical burning requires considerable scientific investigation, coupled with practical knowledge.

The purpose of the papers to follow is to deal with the various problems connected with the combustion of oil fuel. It is proposed to introduce everything up to the most recent practice.

The writer desires to state that he has no connection with any burner or appliance described in these papers, and wherever comparisons are made they will be used as matters of fact for the information of the reader with the intention that such information shall be reliable. The same may be said regarding any data on fuel. The subjects treated will be:

(1) Fuel oil; (2) its combustion; (3) gas analysis; (4) drafts and temperature measurements; (5) burners; (6) furnaces; (7) test data.

The writer invites suggestions for the treating of the various subjects, and if receiving any contributions that will be of any benefit to the readers, will gladly embody such in the papers under their respective headings, giving due credit therefor.

(To be continued.)

PRACTICAL MECHANICS.

Paper No. 10.

(Belting—Continued.)

In the preceding paper the calculations incident to ordinary belting practice were shown. A diagram was given from which values of the rather complex expression for the belt friction and angle of contact may be found. The final results had to be obtained, however, through the application of values to the mathematical formulas. Further, the computations thus far have taken no consideration of high pulley speed and the resulting inertia effect known as centrifugal force. In reality the formulas thus far developed are not sufficiently complete and comprehensive to be of general usefulness. They are, rather, expressive of the laws of variation of the quantities and terms involved.

In the present paper it is intended to combine with the foregoing the effects due to high pulley speed and finally to reduce the whole to a simple diagram from which results may be read off without the use of mathematical computation.

Let us study the forces which exist when a belt section arrives at a pulley and the interrelations of these forces as this section travels around the pulley. The tension, T_2, in the belt as it reaches the pulley is gradually increased on the way around the pulley to T_1 at the point of leaving. It is therefore variable. Due to this tension there is a resulting force normal to the pulley surface, or radial, and acting toward the center of the pulley. This force is likewise variable.

Opposing this normal inwardly-directed force there exists an outwardly-directed force which is constant for all portions of the pulley surface, but which increases with the square of the pulley speed. That is, if the pulley speed is doubled this centrifugal effect becomes four times as great. It varies also inversely with the pulley diameter. To get an expression for the resulting pressure of the belt against the pulley involves, therefore, consideration of these two opposing forces at each minute portion of the arc of contact; the total normal pressure being the summation of all these portions.

This can be shown mathematically to be expressible in the form $T_1 = T_2 \, e^{a \phi} \left(1 - \frac{n v^2}{g}\right)$

In addition to the terms before defined we have here:

n = a constant depending on the weight of the belt.

g = the constant 32.16.

v = the angular velocity of the pulley.

Let us examine this equation. The term $\frac{n v^2}{g}$ will increase as the square of the angular velocity (v) of the pulley. When this angular velocity increases therefore the quantity in parenthesis $\left(1 - \frac{n v^2}{g}\right)$ decreases, and hence the horsepower decreases. At the speed where $\frac{n v^2}{g} = 1$ the quantity in parenthesis becomes 0, and $e^0 = 1$. Hence the horse power becomes 0 since the terms within the brackets become

$$\left(\frac{1-1}{1}\right) = 0$$

In reality this is the critical pulley speed at which the belt would begin to leave the pulley. There would be no normal pressure against the pulley and consequently there could be no power transmitted.

This general formula could be used in any case the engineer might have at hand, and by choosing the appropriate constants for maximum allowable pull, belt speed, coefficient of friction and angle of contact, the horsepower that an inch of belt would transmit could be readily figured. Such a computation would be tedious, however, and to avoid it the accompanying diagram has been worked out by Prof. J. Flather for values of the constants which experience has shown to be good practice.

The belt speeds in feet per minute are at the bottom; the horsepower for large pulleys at the left and right sides, and the angle of contact on the smaller pulley is given at the top. Four curves are drawn in the body of the diagram; two for double belts and two for single.

The diagram is used as follows: Starting at the figure represented by your belt speed as decided upon, proceed upward to the curve of the belt to be used. Then follow a horizontal line to the center line of the diagram, i. e., to the 180° angle of contact. This horizontal line corresponds to the value of the horsepower which one inch of such belt would transmit if the belt covered one-half of the pulley. If the angle of contact is other than 180° proceed parallel to the sloping lines until the vertical line corresponding to the angle of contact is reached; thence horizontally to the right or left margin. The value of the horsepower thus found will be that transmitted for this angle of contact and per inch of width.

For example, suppose we wish to transmit 50 h.p. at a belt speed of 3,500 ft. per minute and shall use a double laced belt. Let us say that the speed ratio is such that but 160° of the smaller pulley is covered by the belt.

Going vertically upward from the 3,500 point of the bottom scale to the double laced curve, then horizontally to the center line of the diagram, we find that at this speed the belt would transmit 5¾ h.p. if covering 180° of the pulley. Proceed now from the 180° line along the sloping line to the 160° vertical line, and thence horizontally to either margin. It is now found that but 5¼ h.p. will be transmitted. Dividing 50 by 5¼ gives 9½ inches, the necessary belt width.

When very small pulleys have to be used with large belts there is less tension permissible owing to the injury resulting from bending. This is provided for in the diagram by the diagonal lines drawn from the lower right-hand corner. If, for instance, the belt above determined were to be used on a 12-inch pulley, follow horizontally along the 5¼ h.p. line to the 12-inch pulley diagonal line and thence vertically upward to the small pulley scale at the top. It is seen that but 4¼ h.p. could be transmitted in this case. It is seen by observing the diagram that the power transmitted increases with the belt speeds up to a certain maximum value beyond which it decreases, finally

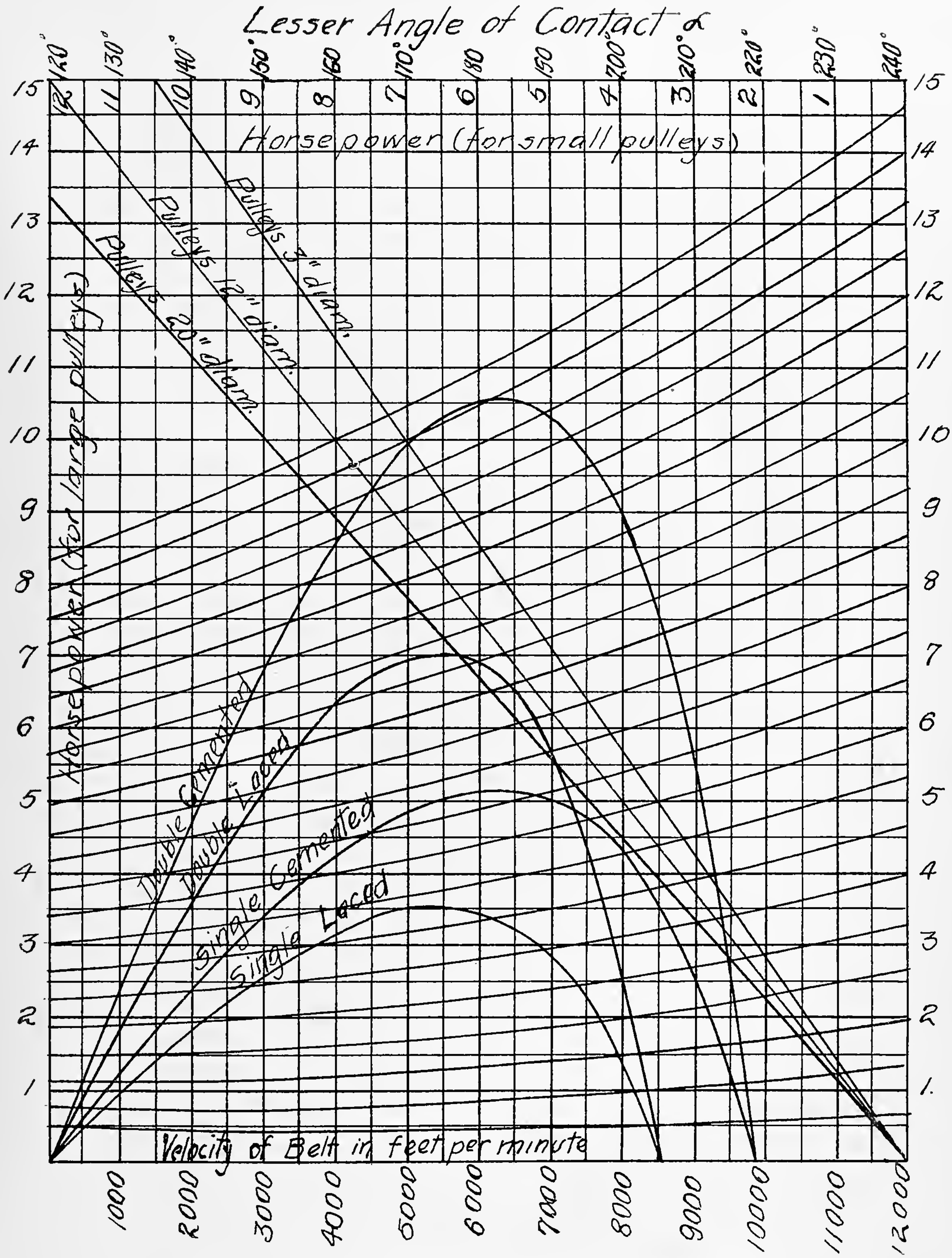


DIAGRAM FOR FINDING HORSEPOWER TRANSMITTED BY BELTING

For explanation see page 252.

falling to zero at about 10,000 ft. per minute for double belts. This is simply the graphical explanation of the effect produced when high pulley speeds are encountered, and is the plotted results of the mathematical equation where the term $\frac{n\ v^2}{g}$ approaches and reaches unity.

From a series of observations extending over a period of nine years, Mr. F. W. Taylor (see A. S. M. E. trans. Vol. XV., p. 204) drew the following conclusions relative to belting practice: "A double belt, having an arc of contact of 180° will give an effective pull on the face of the pulley of 35 pounds per inch of belt width.

"The number of square feet of belt passing around a pulley per minute required to transmit one horsepower is 80 ft. for oak tanned and fulled leather belts and 90 for other types of leather belts. The number of lineal feet of double belting one inch wide passing around a pulley per minute required to transmit one horsepower is 950 ft. for oak tanned and fulled leather belts and 1,100 ft. for other leather belts."

These values given by Mr. Taylor are rather more conservative than those established by other engineers, but this fact is explained as due to the desire on his part to establish a belting standard that would stand for a maximum of reliability rather than a minimum first cost.

CALCULATION OF STEAM ENGINEERING TESTS.

Every steam engineer is at some time during his career called upon to make tests of an engine or boiler or perhaps of an entire plant. The results of these tests if put into the proper form may be the means of causing the manager or owner of the plant to make certain changes in the plant. These changes are bound to effect the engineer. There may be new machinery installed or economy devices; or the character of the load on the plant may be readjusted. In any event, the engineer who has done the testing and experimenting is almost certain to benefit by the results of such tests. The decision of the man in authority, however, will very greatly depend upon the nature of the report he receives from his engineer. If it is based upon sound conservative figures logically deduced from correct observations and intelligibly arranged, the report will have weight with the man to whom it is submitted. Inaccuracy, incompleteness, or ignorance on the part of the engineer, may, on the other hand, be the cause of the manager's rejection of the entire recommendation, even though the cause for such recommendation may be just as urgent and advisable as in the case of the well deduced report.

It behooves every engineer to know how to use the instruments and apparatus with which the results of experimental tests and observations are reduced to terms and values understood by the business man.

In steam engine testing the equipment with which the engineer should be familiar consists of

1. The indicator;
2. The calorimeter;
3. The prony brake or dynamometer.

Besides the necessary steam tables, the following instruments are necessary and should be thoroughly understood:

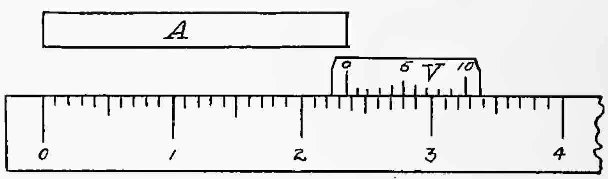
1. The vernier;
2. The slide rule;
3. The micrometer caliper;
4. The planimeter.

The literature covering these various instruments and their uses, while complete, is so scattered among the various books and engineering works, and the explanations are often given in such mathematical mazes that the engineer seldom has the information necessary to get up a thorough report, or even to set up his apparatus correctly before taking the necessary observations.

We therefore intend to assemble this literature and place it before the stationary engnieers so that it may be in practical and convenient form. In doing this, free use will be made of whatever literature may be found on the subjects under special consideration, and with the exception of occasional extensions for the purposes of more complete simplification, no claim toward originality is made.

The Vernier.

The vernier is a device for reading a scale more accurately than is possible with its finest division. Verniers are employed on either straight or circular scales; on the former where extreme exactness is required in determining linear distances with calipers or straight edges, and on circular scales where exact angles are to be measured. Circular verniers are to be



The Vernier.

found on surveyor's transits, or micrometer calipers, and on certain forms of polar planimeters. The vernier consists of a small movable scale adjacent to the main scale or limb, as it it called. The divisions of the vernier are either larger or shorter than those on the main scale. Thus if the main scale is divided into inches and tenths, then the vernier will have ten divisions equal to either nine-tenths of an inch or eleven-tenths of an inch. If the ten divisions of the vernier are equal to nine-tenths of an inch, then the vernier is said to be direct reading. In this case the smallest division on the venier is one one-hundredth of an inch shorter than the smallest division on the main scale, i. e., ten vernier divisions are one-tenth of an inch short, hence one vernier division is one-tenth of one-tenth, or one one-hundredth of an inch short.

In the accompanying figure the main scale is divided into inches and tenths. Ten vernier divisions are equal to nine-tenths of an inch. If the zeros of the two scales be placed together, the first division line of the vernier falls one one-hundredth of an inch short of the first, or one-tenth, division of the main scale. The second vernier division falls two one-hundredths of an inch short of the two-tenths limb division. Following this on through it is seen that the tenth vernier division falls ten one-hundredths short of the

ten limb divisions, or rather it coincides with the nine-tenths inch limb division.

Hence if the vernier be moved along until the first division coincides with the one-tenth limb division, the vernier zero will have moved one one-hundredth of an inch from the limb zero. If the second divisions coincide, the zeros will be two one-hundredths of an inch apart and so on. Suppose we wish to measure the length of the piece A. Place one end opposite the zero of the main scale, and opposite the other end of A place the zero of the vernier scale. The vernier zero is seen to lie between two and three-tenths and two and four-tenths inches. Now follow along the vernier scale until the division coinciding with a main scale division is reached. This is seen to be the sixth vernier division, and therefore the vernier zero is six one-hundredths of an inch beyond two and three-tenths inches and hence the piece A is two and thirty-six one-hundredths (2.36) of an inch in length.

As a rule to be remembered, it may be stated that **the value of the smallest division on the main scale divided by the number of divisions on the vernier scale gives the smallest reading that may be made with the vernier.**

The following rules for reading verniers will apply to any scale units:

First. Read the last subdivision of the main scale passed over by the zero of the vernier. Call this reading (a);

Second. Look along the vernier until a line is found which coincides with some line on the main scale. Read the number of this line from the scale of the vernier. Multiply this number by the value of the smallest reading of the vernier as determined above, and the result is the correct vernier reading. Call this reading (b);

Third. The sum of (a) and (b) is the value sought. Thus in the above example:

and $b = .06$ inch,

$a = 2.3$ inches;

hence $a + b = 2.36$ inches.

Verniers are sometimes made with ten divisions equal in length to eleven smallest main scale divisions. These are termed retrograde verniers for the reason that it is necessary to read back along the vernier scale to find the coinciding lines. Otherwise the principle of operation is the same as with the direct reading vernier, and the above rules apply to either.

In circular verniers the scales frequently read in degrees or half degrees, and the vernier then will have thirty divisions equal in length to twenty nine such half degree divisions. It will thus read one-thirtieth of one-half degree as the smallest reading, or one-sixtieth of a degree or one minute of arc.

N. A. S. E. BALL.

The committee of arrangements for the annual ball to be given under the auspices of California No. 1, and California No. 3 of the National Association of Stationary Engineers, on April 2d, have about completed all preparations. The tickets will be 50c each. The Auditorium Annex will be tastefully decorated and ample provision has been made for refreshments. The committee consists of B. E. George, chairman; H. W. Noethig, secretary; Chas. Dick, treasurer; John Traynor, J. W. Maher, C. C. Elsasser, W. M. Jenkins, P. L. Ennor, J. W. Carter, J L. Davis and W. T. Bonney.

THE WATT-HOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER III.

(Continued.)

Connections of Single Phase Meters.

Fig. 29 shows the diagram of connections for a single phase watt-hour meter when used on a single phase two wire circuit.

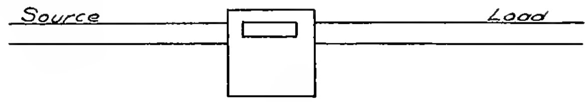


Fig. 29.

Fig. 30 shows the connections of two single phase meters connected so as to register the power flowing

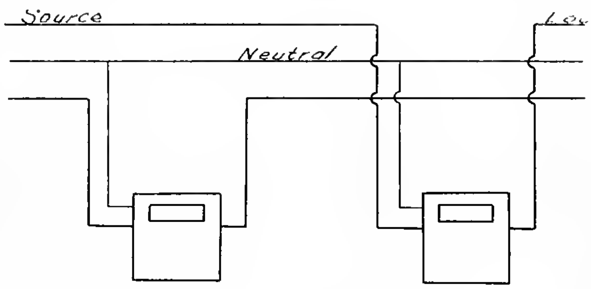


Fig. 30.

in a single phase three wire circuit, and Fig. 31 shows one three wire single phase meter connected for the same conditions. The three wire meter in effect is

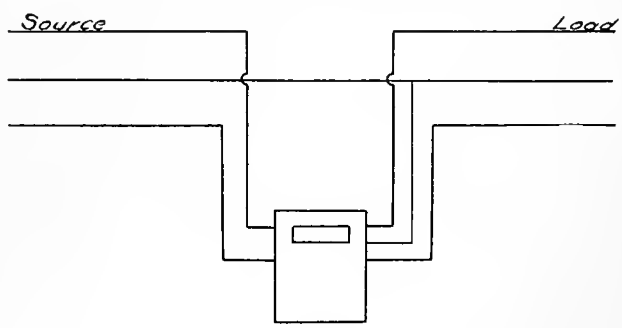


Fig. 31.

really two meters with but one disc and one potential coil, but with a current coil in each side of the line. The fact that the three wire meter has but one potential winding will cause an error in its registration if the voltage between each line and the neutral is not the same. The polyphase meter can also be used as a single phase three wire meter, and is not subject to the error just mentioned, but owing to its greater cost, it is seldom used for this purpose.

One single phase two wire meter can also be used to register the power flowing in a single phase three wire system by using it in connection with a special "three wire" current transformer. Such a transformer has two primary windings and one secondary winding. The two primary windings are connected respectively

in series with each side of the line, the current in the secondary being proportional to the vector sum of the currents in the two primaries. The connections of a single phase meter when used with such a transformer are shown in Fig. 32.

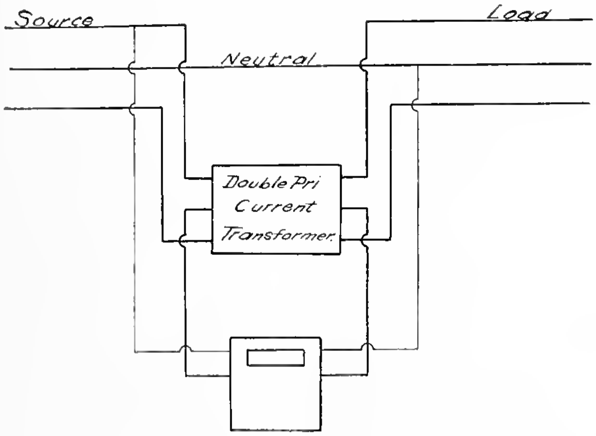


Fig. 32.

Single Phase Meters on Polyphase Circuits.

Two single phase meters may be used to register the power being supplied by either a two phase or a three phase system. For a two phase four wire system, one meter should be connected in each phase as shown in Fig. 33, and when so connected, each meter

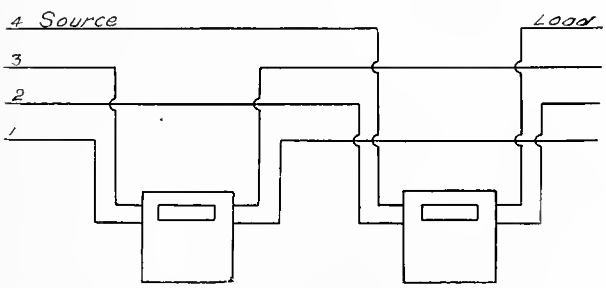


Fig. 33.

will register the power in its respective phase; the algebraic sum of the readings of the two meters will then be the total power supplied by the two phase system.

In the case of a three phase system, the two single phase meters should be connected as shown in

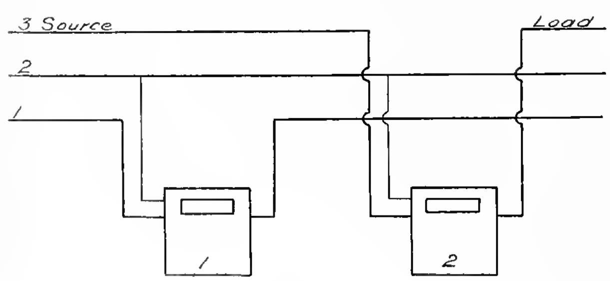


Fig. 34.

Fig. 34. The action of the two meters thus connected can best be explained by reference to the vector diagram.

Fig. 35, in which AC, CB and AB represent the voltages between the phases 2 and 1, 1 and 3, and 3 and 2 respectively; also let CO, BO and AO represent the currents in the phases 1, 3 and 2 respectively, for the condition of unity power factor, and C'O, B'O and A'O the currents for a power factor other than unity.

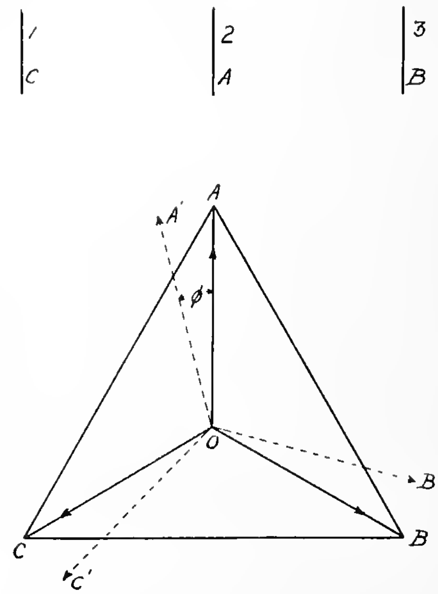


Fig. 35.

We will first consider the case of a balanced system. In this case let e represent the e.m.f. between a line and neutral, then $e = \frac{E}{\sqrt{3}}$, when E is the voltage between lines; also let I represent the current per phase in a balanced system. A three phase system may be considered as consisting of three single phase systems with the neutral as a common return; the voltages of each of the single phase systems being represented by e, and the current by I. The power in each single phase system will be $= (e\,I) \cos \theta$, where θ is the angle by which the current is displaced in phase from the voltage. (Fig. 35); the power in the three phase system will therefore be the sum of the power in the three equivalent single phase systems, or, numerically,

$$P = 3\,e\,I \cos \theta; \text{ and since } e = \frac{E}{\sqrt{3}},$$

we have $P = \sqrt{3}\,E\,I \cos \theta$, which is the fundamental equation for the power flowing in a three phase system.

The two meters connected as shown in Fig. 34 will each have a current I flowing through it, and a voltage E impressed upon its potential winding. In meter No. 1, the current is represented by the line C'O (Fig. 35), and the voltage by CA; and in meter No. 2 the current is represented by B'O, and the voltage by AB; the current being represented as being out of phase by the angle θ. The angle OCA = angle OBA = 30 degrees, which is the angular displacement between the impressed voltage and the line current for unity power factor. For power factors other than unity, this angular displacement is equal to 30 degrees

plus or minus the angle θ, and as can be readily seen from the diagram it will be $(30° - \theta)$ for one meter and $(30° + \theta)$ for the other meter.

The power p', registered by one meter will therefore be

$p' = E I \cos(30° + \theta)$, and the power p'', registered by the other meter will be $p'' = E I \cos(30° - \theta)$, from which

$$p' + p'' = EI \cos(30° + \theta) + EI \cos(30° - \theta)$$
$$= EI\ [\cos(30° + \theta) + \cos(30° - \theta)]$$
$$= EI\ [2 \cos(30° \cos \theta)]$$ and since $\cos 30° = 1/2\sqrt{3}$,

we have

$p' + p'' = EI\sqrt{3}\cos\theta$, which, as shown above, is the equation for the power flowing in a three phase system. It is therefore seen that two single phase meters will register correctly the power in a balanced three phase system.

An unbalanced three phase system may be considered as consisting of a balanced system with the addition of an unbalancing component of either current, voltage or both. When using two single phase meters on an unbalanced three phase system, the unbalanced component will be taken care of as follows:

Suppose that in addition to the balanced current, there is a current flowing between the phases 2 and 3 (Fig. 35), or between 2 and 1; this current would flow either through meter No. 1 or meter No. 2, and as the meter through which it would flow has impressed upon it the voltage of the phases between which this current is flowing, the meter would register the power correctly. In the case of an unbalanced current passing between phases 3 and 1, such current would flow through both meters, and if this unbalanced current is in phase with the voltage BC, between phases 3 and 1, it will be 60° out of phase with the voltage impressed upon each meter, and as the cosine of 60° is 1/2, the correct amount of power will be registered, one-half being registered by each meter. If this current is not in phase with BC, it will be out of phase more than 60° in one meter, and less than 60° in the other meter; the correct amount of power will still be registered, but it will not still be equally divided between the two meters. The angle by which this unbalanced current will be out of phase in one meter will be $(60° + \theta)$, and in the other it will be $(60° - \theta)$, where θ is the angle of displacement between the unbalanced current and the voltage BC. The power registered by one meter will be $= E i \cos(60° + \theta)$, where $i =$ the unbalanced current, and that registered by the other would be $= E i \cos(60° - \theta)$, and the total unbalanced power would be,

$$p = E i \cos(60° + \theta) + E i \cos(60° - \theta),$$
$$= E i\ (2 \cos 60° \cos\theta),$$ and since $\cos 60° = 1/2$,

we have $p = E i \cos\theta$, which shows that the power would be correctly registered in the case of an unbalanced current.

Unbalanced voltages would be taken care of in a similar manner. An unbalanced voltage across phases 1 and 2, or across 2 and 3, would directly affect the potential winding of one or the other of the single phase meters. An unbalancing of the voltage across phases 3 and 1 would affect both meters by distorting the voltage triangle so that the power transmitted would still be correctly registered.

Another method of connecting two single phase meters to register the power in a three phase system

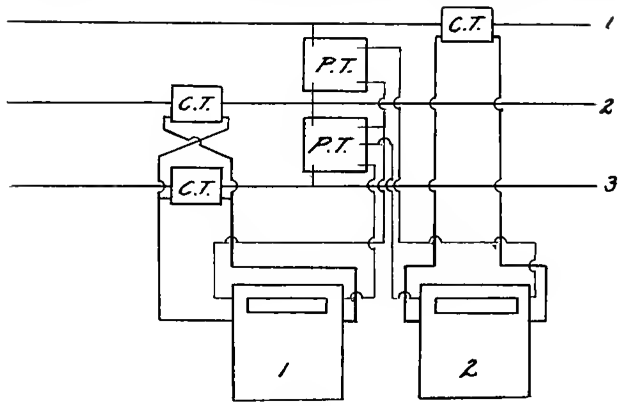


Fig. 36.

in conjunction with current and potential transformers is shown in Fig. 36; the relations of the currents and voltages being shown in the vector diagram,

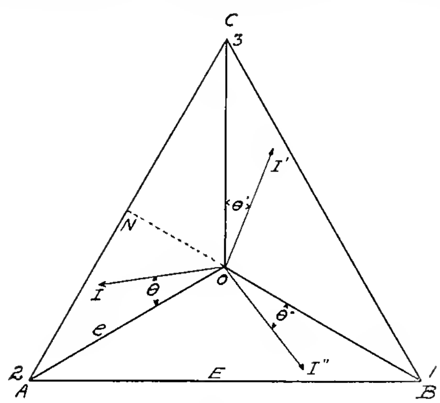


Fig. 37.

Fig. 37. Let I, I' and I'' represent the currents in the three legs of a three phase system; E being the voltage between lines and e the voltage between any line and neutral. Also let θ, θ', and θ'' represent the angles by which the currents are displaced from the position of unity power factor; we will assume the voltage to be balanced, since this makes the explanation somewhat simpler. The true power is $P = e\ I \cos\theta + e\ I' \cos\theta' + e\ I'' \cos\theta''$. Meter No. 1 has currents I and I' flowing through its winding (that is, the resultant of these currents), and the voltage, E, CA, impressed upon it; it is used with a multiplier of 1/2.

Meter No. 2 has the current I'' flowing through it, and the voltage Bn, impressed upon it; $Bn = (3/2)\ e$. Let P represent the total power, P' the power registered by meter No. 1 and P'' the power registered by meter No. 2,

$$P' = EI' \cos(30° - \theta') + EI \cos(30° + \theta).$$

$$P'' = \frac{3}{2}\ e\ I'' \cos\theta''.$$

$$P = \frac{P'}{2} + P''$$

$$= \frac{EI'\cos(30-\theta')+EI\cos(30+\theta)}{2} + \frac{3}{2}eI''\cos\theta''$$

and $\cos(30^\circ - \theta') = \cos 30^\circ \cos\theta' + \sin 30^\circ \sin\theta'$
$\cos(30^\circ + \theta) = \cos 30^\circ \cos\theta - \sin 30^\circ \sin\theta$;

also, $\cos 30^\circ = \frac{\sqrt{3}}{2}$, $\sin 30^\circ = \frac{1}{2}$, and $e = \frac{E}{\sqrt{3}}$

whence $P = E\left[\frac{I\sqrt{3}}{2}\cos\theta - \frac{I\sin\theta}{2} + \frac{I'\sqrt{3}}{2}\cos\theta' + \frac{I'}{2}\sin\theta'\right]\frac{1}{2} + \frac{E\sqrt{3}}{2}\cos\theta''\,I''$

$$= \frac{\sqrt{3}\,E}{4}(I\cos\theta + I'\cos\theta') + \frac{E}{4}(I'\sin\theta' - I\sin\theta) + \frac{E\sqrt{3}}{2}\cos\theta''\,I''.$$

The vector sum of the currents in a three phase three wire system is zero, therefore $I''\cos\theta'' = I\cos(60-\theta) + I'\cos(60+\theta')$, reducing this we get

$I'\sin\theta' - I\sin\theta = \frac{2}{\sqrt{3}}[\frac{1}{2}(I\cos\theta + I'\cos\theta') - I''\cos\theta'',]$ substituting this for $I'\sin\theta - I\sin\theta$ in the above and substituting $\sqrt{3}\,e$ for E, we derive,

$$P = \frac{3}{4}e(I\cos\theta + I'\cos\theta') + \frac{e}{2}\left(\frac{I}{2}\cos\theta + \frac{I'}{2}\cos\theta' - I''\cos\theta''\right) + \frac{3e}{2}I''\cos\theta''.$$

whence $P = eI\cos\theta + eI'\cos\theta' + eI''\cos\theta''$.

The particular feature of this connection is that it gives an indication of how well the system is balanced; if the system is perfectly balanced the two meters will register the same power, taking into consideration, of course, the multiplier of 1/2. This is true with the connection previously described and most often used, only when the power factor is unity.

If the system is perfectly balanced, either of the meters can be relied upon to record the total power, regardless of the value of the power factor, in which case the dials of meter No. 1 would be read without a multiplier, and meter No. 2 would have a dial multiplier of 2.

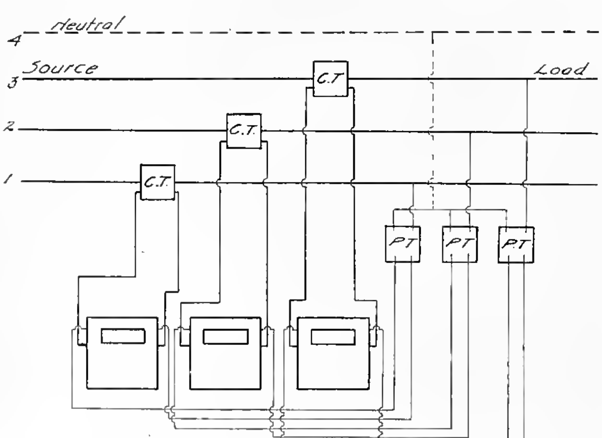


Fig. 38.

In Fig. 38 is shown the connections of three single phase meters for measuring the power in three phase, three and four wire systems. The three phase circuit is metered in this case simply as three single phase circuits, the current in each phase being the current in one of the single phase circuits, and the voltage of each single phase circuit being the voltage from the corresponding line to the neutral. The sum of the readings of the three meters will be the kilowatt-hours supplied by the three phase system.

The advantage of this connection for the three wire system is that the meters operate under better power factor conditions than with the usual two meter method. With this method the current and e.m.f. of each meter will be in phase when the power factor of the load being metered is unity, while with the two meter method the current and e.m.f. are 30° out of phase.

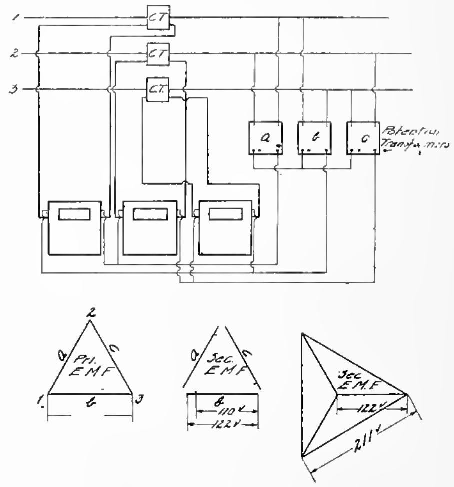


Fig. 38a.

Figure 38 (a) shows another method of connecting the potential transformers for measuring the power flowing in a three phase three wire system by means of three single phase meters. This connection, with certain primary voltages, permits the use of standard ratio potential transformers, otherwise the connection shown in Fig. 38 (a) will require ratios other than the standard. This method is especially applicable to 2300 volt circuits, the standard potential transformer used in this case would be rated 2200 volts primary, and 110/122 volts secondary, the higher secondary voltage (122) being used as is indicated in the figure. With a 2300 volt primary, a secondary voltage of approximately 220 volts would be obtained from the potential transformers, thereby permitting the use of standard 220 volt meters. When meters are used in this manner, a multiplying factor, $\frac{R \times R'}{3}$, is employed in obtaining the total reading, in which R = the ratio of the current transformers and R' = ratio of the potential transformers ($= \frac{2200}{122}$).

Determination of Power Factor by Means of Two Single Phase Meters.

The method of metering with two single phase meters on a balanced three phase system has an advantage over the polyphase meter when it is desired

to obtain the average power factor of the load, which can be done by applying the following formula:

$$\text{Average Power Factor} = \frac{P' + P''}{2\sqrt{(P')^2 - (P' \times P'') + (P'')^2}}$$

where P′ and P″ represent the readings of the two single phase meters. The deduction of this formula is as follows: In the vector diagram, Fig. 38 (b) AB,

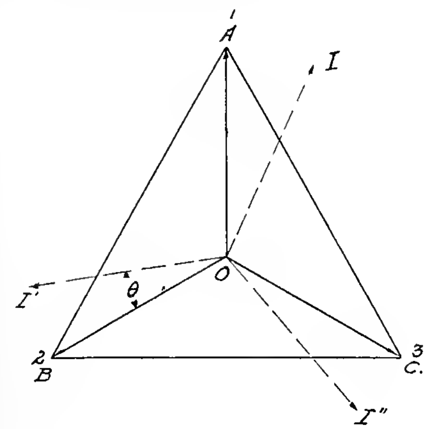


Fig. 38b.

AC and BC represent the voltages between the phases of a three phase circuit, and OI, OI′ and OI″ represent the currents in the legs 1, 2 and 3 respectively, and which are displaced from the position of unity power factor by the angle θ. Now suppose that the current coil of meter No. 1 is connected in leg No. 2, and that its potential coil is connected across AB; also that the current coil of meter No. 2 is connected in leg No. 3 and its potential coil across AC. Then the power, P′, being registered by meter No. 1 will be = AB. OI′ cos ϕ, where ϕ is the angle between AB and OI′ = $(30° + \theta)$, θ being the angle of current displacement. The angle OBA is of course 30°. Denoting the voltage AB by E, and the current OI′ by I, we have $P' = EI \cos (30 + \theta)$ and similarly, the power being registered by meter No. 2 will be $P'' = EI \cos (30 - \theta)$, (assuming the system to be balanced). Then by trigonometry we have,

$$\cos (30 + \theta) = \cos 30 \cos \theta - \sin 30 \sin \theta$$
$$\cos (30 - \theta) = \cos 30 \cos \theta + \sin 30 \sin \theta$$

But $\cos 30° = 1/2 \sqrt{3}$, and $\sin 30° = 1/2$,

Therefore $\cos (30 + \theta) = 1/2 \sqrt{3} \cos \theta - 1/2 \sin \theta$

and $\cos (30 - \theta) = 1/2 \sqrt{3} \cos \theta + 1/2 \sin \theta$

Substituting these values in the above equations for P′ and P″ we have:

$$P' = EI\,(\tfrac{1}{2}\sqrt{3} \cos \theta - \tfrac{1}{2} \sin \theta), \text{ hence}$$

$$EI = \frac{P'}{(\tfrac{1}{2}\sqrt{3} \cos \theta - \tfrac{1}{2} \sin \theta)}$$

$$P'' = EI\,(\tfrac{1}{2}\sqrt{3} \cos \theta + \tfrac{1}{2} \sin \theta), \text{ hence}$$

$$EI = \frac{P''}{(\tfrac{1}{2}\sqrt{3} \cos \theta + \tfrac{1}{2} \sin \theta)} \text{ or since } EI = EI,$$

we have

$$\frac{P'}{\tfrac{1}{2}\sqrt{3} \cos \theta - \tfrac{1}{2} \sin \theta} = \frac{P''}{\tfrac{1}{2}\sqrt{3} \cos \theta + \tfrac{1}{2} \sin \theta}$$

By trigonometry, $\sin \theta = \sqrt{1 - \cos^2\theta}$, and substituting this value

$$\sqrt{3}\,P' \cos \theta + P' \sqrt{1 - \cos^2 \theta} = P'' \sqrt{3} \cos \theta - P'' \sqrt{1 - \cos^2 \theta},\ \sqrt{1 - \cos^2 \theta}\,(P' + P'') = (P'' - P')\sqrt{3} \cos \theta.$$

Squaring and transposing, we have,

$$\cos^2 \theta\,[\,4\,(P')^2 - 4\,P'\,P'' + 4\,(P'')^2\,] = (P' + P'')^2,$$

Whence

$$\cos \theta = \frac{P' + P''}{2\sqrt{(P')^2 - P'\,P'' + (P'')^2}} = \text{average power factor}$$

The true instantaneous power factor can also be determined by this method, using two indicating wattmeters.

Single Phase Meters for Six Phase Circuits.

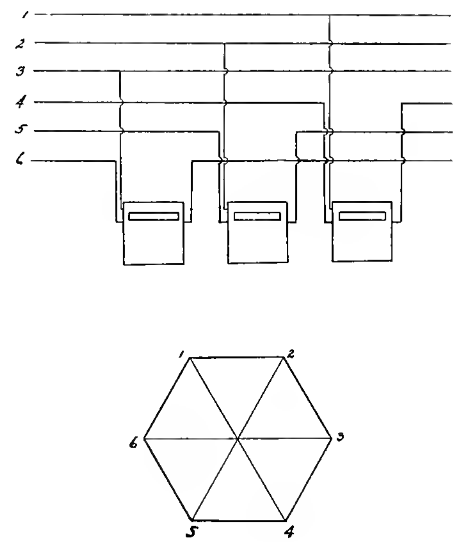


Fig. 39.

Three single phase meters can be used for measuring the power in a six phase system by connecting them as shown in Fig. 39.

(To be continued.)

PROBLEMS DISCUSSED BY CALIFORNIA NO 3. N. A. S. E.

BOILER REPAIRING—How could a bag in a boiler be repaired without putting on a patch?

Heat the bagged surface with a portable forge (by removing the legs from an ordinary hand forge it can usually be placed directly under the boiler)—and when the plate is red it can be hammered back to normal position. A bag has been pulled back, when hot, by putting a jaw-brace inside the boiler and then drilling a hole in the center of the bag so that a bolt can be used to pull the sheet back into line. If the bag is very bad, however, the best practice would be to put a patch on after cutting out the stretched portion of the sheet. This would insure the job while a bag hammered or pulled back into line may leave the metal weakened.

PORTLAND SECTION A. I. E. E.

The next regular meeting of the Portland Section will be held in the Assembly Hall of the Electric Bldg., Tuesday evening, March 22, 1910 at 8 P. M. A paper will be presented by Mr. O. B. Coldwell on Efficiency Tests of a Water Wheel Unit.

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
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CONTENTS

Licensing Steam Engineers

At first thought it seems unjust to deny a man the privilege of running a steam plant because he cannot answer a list of complex conundrums propounded by a board of examiners. The engineering magazines abound with examples of absurd and insidious catch questions that have been skillfully contrived as traps to the unwary. Even at the best, an engineer enters an examination with no little trepidation and fear of its outcome. He is placed at much the same disadvantage as is a woman in curl papers. Nervousness throws him off his guard, and he fails to pass a creditable examination, whereas his less competent, but more self possessed, competitor obtains a satisfactory rating.

The fault lies not with the engineer, but with the system . The inadequacy of the written test is well known and many more or less successful attempts have been made to find a suitable substitute, or at least a supplement. With proper preparation, however, a capable engineer seldom fails in a fair test. Unfortunately favoritism is frequently charged, especially in municipal examining boards which may be closely linked with local politics. Some method that will remove the examiners from suspicion of these corrupting influences is greatly to be desired. We believe that no charge of intentional dishonesty has ever been proven against a member of one of these boards. Nevertheless, it is no more than right that they should be so placed that they may possess those attributes demanded of Caeser's wife.

Experience has shown that equitable administration of a State license law is the most satisfactory solution of this problem yet devised. Some other more acceptable means is a possibility of the future, but until its excellence has been demonstrated, the State license law should receive the active support of every broad-minded engineer. Most of the opposition to it comes from labor leaders, who lose sight of the fact that its prime purpose is not to specify who are competent engineers, but to protect the public. A boiler explosion is disastrous, not only to the engineer in charge, but also to all persons in the vicinity, and every precaution is taken to prevent such an accident. We find that some of the examining boards confine their questions largely to boilers and their auxiliaries, as they are the most prolific source of accidents in power plants.

Steam is like a poison in that it is dangerous in unskilled hands. Public safety requires the licensing of the druggist who dispenses the poison and likewise of the engineer who operates the steam plant. We would suggest that even the firemen and the water tender should be properly impressed with the life hazard that attends their work and be compelled to occasionally show their proficiency.

PERSONALS.

W. W. Briggs has been appointed Jovian Statesman for Northern California.

Al Palmer of the Philips Insulated Wire Company of Pawtucket, R. I., is visiting San Francisco.

W. J. Davis, Jr., Pacific Coast engineer of the General Electric Company, is making an Eastern trip.

H. B. Squires of Otis & Squires of San Francisco is in the Northwest with H. Krantz of Brooklyn, N. Y.

John Coffey Hays, manager of the Mount Whitney Power Company of Visalia, was a recent San Francisco visitor.

O. I. Cheney, chief electrician at the Mare Island Navy Yard, was a visitor to San Francisco during the past week.

H. V. Gates, president of the Klamath Falls Light and Water Company, has returned to Hillsboro, Ore., from a trip to Mexico.

E. M. Scribner has been appointed Western sales manager of the Arrow Electric Company of Hartford, Conn. with headquarters in Chicago.

Arnold Pfau, engineer with the Allis-Chalmers Company, is in San Francisco during the course of a Pacific Coast tour, after which he will return to Milwaukee.

K .G. Dunn, engineer with Hunt, Mirk & Co., Coast representatives of the Westinghouse Machine Company, has returned from a business tour of the Pacific Northwest.

H. H. Noble, president of the Northern California Power Company, was recently slightly injured by being thrown from a horse while inspecting power properties near Redding, Cal.

A. W. Vinson, Pacific Coast engineer for the Cutler-Hammer Manufacturing Company, recently returned to San Francisco from a meeting of the company's engineers at Milwaukee.

C. A. Greenidge, recently manager of the electric department of the Utica Gas and Electric Company, has joined the staff of J. G. White & Co. of New York as engineer of the operating department.

A. E. Hursh recently resigned his position as manager for the San Joaquin Light and Power Company at Selma, Cal., and will in future be in charge of the Gas and Power Company's plant at Coalinga.

Thomas Mirk of Hunt, Mirk & Co. returned last week from Los Angeles after spending considerable time in the South in connection with the closing of some good contracts for Westinghouse-Parsons turbo-generators.

Frank McGovern of the Archer-McGovern Company of New York, which is one of the largest second-hand machinery dealers in the United States, is in San Francisco in connection with the purchase of some of the discarded 25-cycle electrical apparatus from the United Railroads.

Pacific Coast engineers recently elected associate members of the American Institute of Electrical Engineers include T. F. Arnott, quartermaster electrician, Puget Sound Navy Yard, Charleston, Wash.; C. E. Christiansen, electrical engineer Toledo Light, Power and Manufacturing Company, Toledo, Ore.; W. T. Drake, instructor in Polytechnic College of Engineering, Oakland, Cal.; W. S. Johnson, assistant in electrical engineering department, Pacific Light and Power Company, Los Angeles, Cal.; W. D. A. Peaslee, student Stanford University, Stanford, Cal.; L. M. Perrin, draughtsman Southern Pacific Company San Francisco; H. S. Shedd, superintendent of operation, Great Western Power Company, Oakland, Cal.; G. H. Stockbridge, assistant superintendent of transmission, Southern California Edison Company, Los Angeles, Cal.; C. G. Worthington, consulting electrical engineer, Vancouver, B. C.

MEETING OF PACIFIC COAST GAS ASSOCIATION.

The Pacific Coast Gas Association calls advance attention to the fact that the eighteenth annual convention will convene at Los Angeles, Cal., September 20th, 1910. President W. B. Cline has already announced that the Los Angeles Gas & Electric Corporation, the Pacific Light & Power Company and Southern California Edison Company will join in entertaining the members attending the Convention.

SAN FRANCISCO JOVIANS MEET.

In response to the call of W. W. Briggs, the newly appointed Statesman for Northern California, an enthusiastic meeting of the Sons of Jove was held at Tait's cafe on Friday evening, March 18, 1910. This was the first of a number of "Jovian blowouts" yet to come, and its success augurs well for a revival of interest among local electrical men.

TRADE NOTES.

Otis & Squires of San Francisco have been appointed agents in California, Arizona and Nevada for the Durant Electric Company of Chicago, Ill., makers of rubber covered iron telephone drop wire.

Hunt, Mirk & Co. have sold the Union Lumber Company a 1,000 kw. Westinghouse-Parsons turbo-generator set, together with switchboard, exciter and condensers. This additional equipment will be installed in the company's plant at Fort Bragg, Cal.

The Western Electric Co. has sold the Philippine Telephone & Telegraph Co., for use in the Manila office, 340 additional multiple. Two complete train-dispatching telephone outfits have been sold to the Southern Pacific Company, also one set of messenger equipment.

The General Electric Company reports the following sales: To Lidgerwood Manufacturing Co., three I. T. C. 5017 300-h.p. 575 r.p.m. 440-v. hoist motors, with type M control. Four I. T. C. 5013 52-h.p. 565 r.p.m. 440-v. hoist motors, with T. 10 controllers, for use on the construction of the addition to the Great Western Power Co.'s dam at Big Bend.

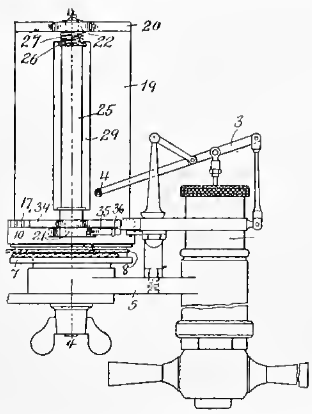
Hunt, Mirk & Co. have closed a contract with the Municipal Light and Power Company of San Francisco for an additional Westinghouse-Parsons turbo-generator having a capacity of 1,000 kw. for an extension of the existing electric power plant in the Claus Spreckels building annex on Stevenson street. The same firm will also furnish the additional Stirling boilers, condensers and cooling plant.

The 1500-k.w., 3-phase generator, which the Allis-Chalmers Company recently sold to the interests represented by W. H. Metson, is to be installed in a new power house near Bodie, Mono County, Cal., (instead of on the Nevada-California Power Company's Bishop Creek development). The generator will be direct-conected to a turbine water wheel operating under a head of about 350 feet. Current will be transmitted to Bodie and to mines in Nevada. The Fort Wayne Electric Works will supply the switchboard for the new plant and also some transformers.

The Pacific Light and Power Company of Los Angeles has just ordered from the General Electric Company two 12,000 kw. Curtis vertical steam turbine generators—rated A. T. B. 8, 12,000 kw., 750 r.p.m., 9,000 v.—together with one horizontal Curtis turbine exciter set, rated C. C. 4, 100 kw., 2,400 r.p.m., 250 v. These machines are to be installed in the company's present Redondo plant, in which there are now installed three 5,000 kw. engine-driven units consisting of General Electric generators direct connected to McIntosh & Seymour engines. The new turbines will be installed in one end of the building in the space now occupied by circulating pumps and auxiliaries.

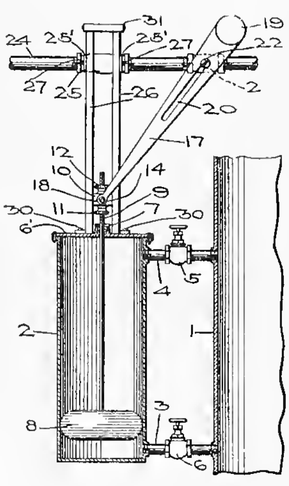
PATENTS

951,131. Continuous-Card Indicator. Amos P. Kinney, Quincy, Mass., assignor to American Steam Gauge and Valve Manufacturing Company. An indicator comprising a card-carrying drum, a pressure-actuated marker arranged to reciprocate beside said drum and parallel to the axis theeof,



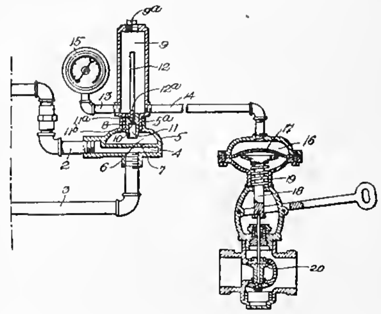
means for oscillating said drum in synchronism with the strokes of the engine being tested, and a stationary feed pawl arranged to engage and arrest said drum during a portion of the return oscillation of the drum, to produce a forward feed thereof and of the card relatively to the marker.

950,533. Automatic Boiler-Feeder. Charles J. Lindberg, Malmo, Minn. In a device of the character described, the combination with a cylinder, of a float, a stem extending from said float and projecting beyond one end of said



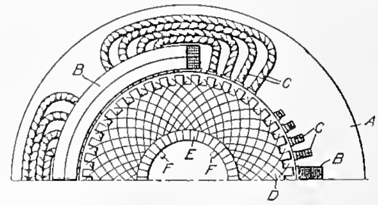
cylinder, an operating lever, one end carried pivotally by said stem, the other end free, a slot being centrally formed on said operating lever, a throttle valve, the stem of which passes through said slot, and adapted to be turned by rocking of said lever.

950,493. Feed-Water Regulator. Fred H. Plouff, Boston, Mass. In a feed-water regulator, in combination, a water and steam chamber adapted to be connected with the water and steam spaces of a boiler, a liquid chamber separated from said water and steam chamber by a heat-transferring partition, a reservoir with a passage leading therefrom to said liquid chamber, a pipe mounted in said passage and extending therefrom into said reservoir and furnished, preferably near its lower end, with apertures leading into said reservoir and a conduit leading from said reservoir to a



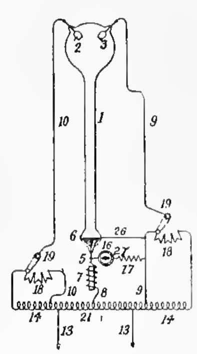
chamber adapted by suitable mechanism to control a water supply for said boiler; substantially as described.

951,357. Single-Phase Commutator-Motor. Ernst F. W. Alexanderson, Schnectady, N. Y., assignor to General Electric Company. An alternating current motor, comprising a stator, an exciting winding thereon, an inducing winding distributed in slots on the faces of the poles of the exciting



winding producing a relatively excessive magnetizing effect at the pole tips, an armature having the coils of its winding of a pitch approximately equal to the circumferential width of the pole faces of the exciting winding, a commutator and brushes for the armature, and connections for including the armature in a local closed circuit.

951,085. Single-Phase Gas or Vapor Electric Device. Percy H. Thomas, Pittsburg, Pa., assignor to Cooper Hewitt Electric Company. In a system of electrical distribution, a gas or vapor electric apparatus provided with a starting band, two or more positive electrodes and a negative electrode, a source of single phase alternating current connected



with the said apparatus, a choke coil interposed at a suitable point in the system, a starting device capable of creating a critical strain within the apparatus, and means for applying to the apparatus a momentary initial excess of potential, the current produced by the extra potential being adapted to pass through the choke coil.

INDUSTRIAL

THE GOEHST INSULATION CUTTER.

Te accompaning pictures show the method of using the Goehst insulation cutter, which is heing placed on the market by Mathias, Klein & Sons of Chicago, Ill. By the use of this cutting plier it is claimed that one man can do hetter work in less time than three men working with knives.

When cutting insulation for joints the wire is held in the V-shaped cutters and the jaws pressed together so as to cut the insulation as shown in Fig. 1. The insulation is then pressed off with the flat nose of the pliers, as shown in Fig. 2.

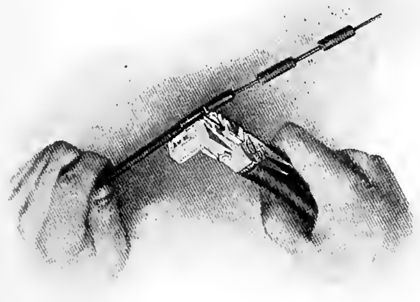


Fig. 2.

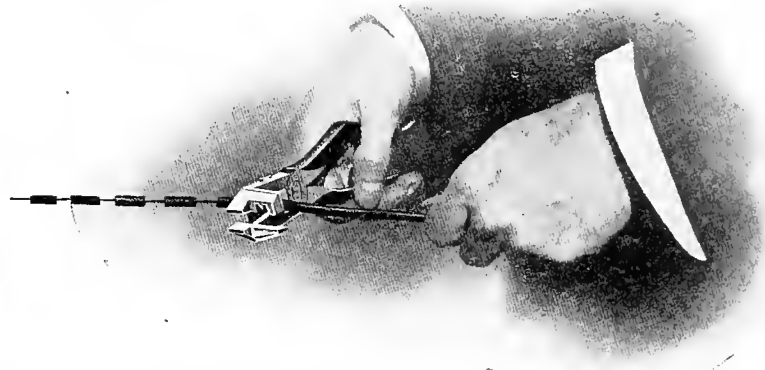


Fig. 1.

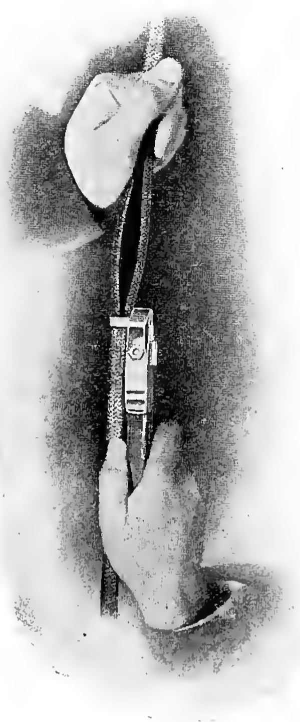


Fig. 3.

Fig. 3 shows the method of slitting Duplex wire. By inserting the jaws in the wire and drawing the pliers toward the operator, the wire is cut rapidly and clean, leaving the two strands perfect with the braid removed.

ANNOUNCEMENTS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

On Tuesday evening, March 8th, there was a meeting of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers co-operating, in the Engineering Societies Building, New York, with a paper by H. G. Stott, Mem. Am. Soc. M. E., superintendent of motive power of the Interborough Rapid Transit Company, New York, and R. J. S. Pigott on "Tests of a 15,000 kw. Steam Engine Turbine Unit." The paper related to the installation of low pressure turbines at the Fifty-ninth street station of the Interborough Rapid Transit Company, New York, and presented a discussion of the most important development in steam engineering since the commercial introduction of the steam turbine.

The turbines operate on exhaust steam from the engines, with which the station was originally equipped. These are double compound engines of the Manhattan type with horizontal high-pressure and vertical low-pressure cylinders. The generators of the engines are capable of safely carrying a load of 8000 kw. each, but the normal economic ratings of the engines is only 5000 kw. The low-pressure turbines, three of which are in process of installation, were added primarily to increase the output of the station. By the addition of the turbines the engines can be run economically up to the full capacity of their generators and there is besides the current from the turbo-generators, making a total output of 15,000 kw. per combined unit, or nearly double the previous maximum output; and with an average improvement in the economy of 25 per cent (between the limits of 7000 kw. and 15,000 kw.) over the results obtained by the engine units alone.

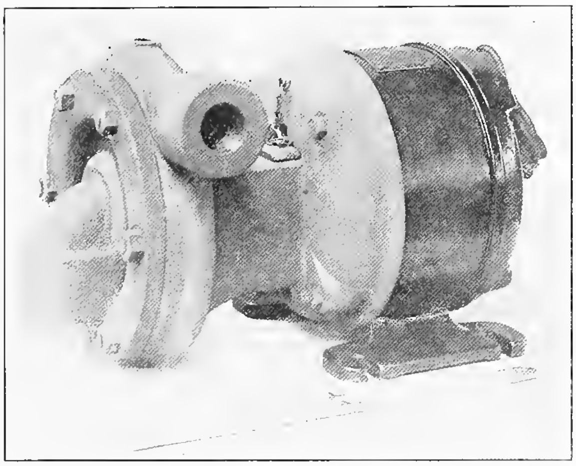
Boston Meeting, March 11, 1910.

The monthly meeting of the American Society of Mechanical Engineers in Boston was held Friday evening, March 11th, in the auditorium of the Edison Electric Illuminating Company. The Boston Society of Civil Engineers and the Boston section of the American Institute of Electrical Engineers co-operated in the meeting. The paper was by Mr. M. W. Alexander, Mem. Am. Soc. M. E., who has been so long identified with the educational work and the training of the apprentices at the works of the General Electric Company, West Lynn, Mass. The subject of the paper is "The Training of Men—A Necessary Part of the Modern Factory System."

ELECTRIC PUMPS FOR HOUSEHOLD WATER SUPPLY.

In that rapidly enlarging class of country houses and isolated homes where electrical power is available the dependency for water supply need no longer rest on the unreliable and expensive operation of windmills and gasoline engines. Theoretically cheap as these agents are supposed to be, the one involves a large first cost with a service as little dependable as the wind which serves it, while the other requires the attention of a trained mechanic to supervise the complicated engine, to say nothing of the explosive nature of the fuel employed, and the dangers of ignorance in its operation.

But the electric motor driven pump for house service, once installed, becomes a subject removed from the mind of the householder. It can be started and stopped by throwing a switch. An automatic cut-off can also be provided which will stop the pump when the water level in the roof tank has reached a predetermined height, starting the motor again before the storage supply has run low.



Electric Motor Driven Volute Pump.

As shown in the accompanying illustration, the motor driven volute pump for this class of service is compact and solidly constructed. The motor is of the Westinghouse alternating current induction type, in which all special or delicate parts have been eliminated, resulting in a thoroughly dependable, sturdy, completely enclosed electrical machine, which transmits its output through a shaft directly to the impeller blades rotating in the cast iron case seen at the left. This volute pump is designed to deliver 800 to 1000 gallons per hour against heads up to 50 feet, when running at 2800 to 3300 revolutions per minute. The intake is shown at the left, entering at the center of the pump case, while the discharge orifice is the hole, threaded for a one-inch pipe, seen opening toward the observer. There are, of course, no valves in this pump, and packings, pistons, etc., are also eliminated. The pump, which is arranged to be bolted onto the motor frame, making a compact unit, was designed and built by Henry R. Worthington, Harrison, N. J. Motors for this class of duty are built by the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa.

CATALOGUE EXPERIENCE MEETING OF TECHNICAL PUBLICITY ASSOCIATION.

The Technical Publicity Association held a well attended meeting on Thursday evening, February 10th, in the galleries of the National Arts Club, 14 Gramercy Park, New York. It was in the nature of an experience meeting on the subject of "Catalogues." An interesting and prolonged discussion, participated in by many of the advertising managers representing some of the most prominent of the technical manufacturing concerns and by representatives of publishing and paper firms, made the session a profitable one.

Considerable sentiment in favor of adopting standard sizes for commercial literature of this sort was found at the meeting. Many complained of the uneveness and lack of system among numerous catalogues, making them difficult to file.

An interesting paper by Martin P. Rice, head of the publication bureau of the General Electric Co., at Schenectady, N. Y., was read to the edification of those present Many attractive specimens of current catalogues were exhibited by the speaker and also by other members of the T. P. A.

J. George Frederick, editor of Printers Ink, dwelt on the logical relation of catalogues to an advertising campaign and spoke in favor of giving wider publicity to the catalogue to increase its distribution. Mere listing of goods and prices, he declared, should come after an impression has been made upon the reader by the catalogue.

Leroy Fairman, editor of Advertising & Selling, advocated the importance of making things perfectly plain in literature of this sort. "There is danger," he said, "in assuming that people who read catalogues know more than they really do know."

A. P. Waterman, advertising manager of the Holtzer-Cabot Electric Co., brought to the attention of the members a special cover for catalogues. This is in the form of a binder for loose leaf sheets, or sections of sheets, held together by fasteners; the back of binder folded so that it will expand to accommodate a great number of additional leaves.

C. R. Lippmann, advertising manager of the Genuine Bangor Slate Co., stated that certain engineering and architectural societies have adopted as standard for catalogues, size 5x8 inches. This is a convenient pocket size.

Vechten Waring stated that any book ¼ inches thick or thicker should be lettered on the backbone for easy finding. Referring to juxtaposition of cuts and reading matter he thought it far better advertising policy to say underneath a cut what it is, rather than designate it by the letter "A," "B" or "C." Translate sectional drawings into perspective drawings for easy reading and understanding. A title alone on title page is poor business. Abundant room is there for some strong selling argument.

F. F. Coleman mentioned an interesting experience in connection with the filing of catalogues which varied in size from 3x5 inches to 15x24 inches and various intermediate sizes. He advocated catalogue sizes 6x9 and 9x12 and that catalogues intended to be filed away for reference should be made of uniform size.

F. E. Dayton of Rodgers & Co., said that 9x12 inch size has been adopted by Master Car Builders' Association and that books which are to be kept for a long time should be bound on the long dimension.

Hal Marchbanks of the Hill Print shop, spoke in favor of simplicity in cataloging and presenting a technical product.

Chairman H. M. Davis, of the committee the proposed Uniform Advertising Contract, reported that the final draft of the contract which had been discussed at several of the previous monthly meetings, had been adopted by the members of the T. P. A. without a dissenting vote. Forty-eight votes, representing thirty-seven companies, were received.

A number of new members were admitted into the Association. The T. P. A. has enjoyed a steady growth in membership and influence. At the next monthly open meeting and dinner to be held Thursday, March 10th, at the National Arts Club, a lively discussion on the question of the proposed increase in second class mail matter is expected.

NEWS NOTES

FINANCIAL.

SPOKANE, WASH.—The City sinking fund committee awarded the sale of the Spokane waterworks bonds issue of $400,000 to N. W. Halsey & Co. of New York for $410,280.

DRAIN, ORE.—$15,000 in water bonds and $5,000 in sewer bonds have been voted. The former carried by a vote of 40 to 4 and the latter by a vote of 41 to 7. $6,000 of the money received will be tendered to the Drain Water Company for its plant now in operation.

COUER D'ALENE, IDA.—The Council has announced that a resolution be prepared authorizing an election in 40 days on an issue of bonds aggregating $167,000 for the purchase of the city waterworks, of auto fire fighting apparatus and for grading in three improvement districts.

SAN FRANCISCO.—The Supervisors have passed to print an ordinance by which the Mayor was empowered to enter into a contract with the Tuolumne Water Supply Company for the purchase for $400,000 of lands, water rights and all properties in the county of Tuolumne in Tuolumne in connection with the Lake Eleanor water supply for the city of San Francisco, and also to sign an option with the same company for $600,000 for the purchase of the so-called Cherry Creek lands and water rights.

LOS ANGELES, CAL.—The City Council has passed an ordinance calling for an election to be held in this city April 18th, submitting to the voters the proposition of incurring a debt of $3,000,000 for constructing docks, wharves, warehouses within the city; also for improving and constructing streets and highways to navigable waters; constructing and maintaining canals and waterways to navigable waters; also $3,500,000 for acquiring and constructing a municipal improvement, as follows: Works for generating and distributing electricity for supplying light, heat and power; including acquisition of lands, water rights, machinery, apparatus, and construction of electric generating works, distributing line, etc.; $2,000,000 will be expended on docks and wharves, streets, etc., in what is known as the outer harbor at San Pedro, and $1,000,000 on wharves, docks, warehouses, etc. in what is known as the inner harbor at San Pedro.

INCORPORATIONS.

WENATCHEE, WASH.—The Entiat Light and Power Company has been incorporated by C. A. Harris of Wenatchee.

OLYMPIA, WASH.—The Wenas Electric Power Line of North Yakima has been incorporated with a capital stock of $15,000 by Stephen D. Saunders, Peter C. Mann, M. B. Miles, Lewis J. Anderson and E. G. Towsan.

NEW WESTMINSTER, B. C.—The Stewart-Portland Canal, Power, Light and Water Company has been incorporated with a capital of $250,000. The object of the company is to supply the townsite of Stewart and vicinity with water, gas and power.

BRAWLEY, CAL.—The Westmoreland Water Company has been incorporated. The directors are H. C. Oakley, Peter Hovley, Philo Jones, G. T. Wellcome and G. B. McWilliams. The object of the company is to handle the domestic water system of the new town.

SAN FRANCISCO.—Articles of incorporation have been filed in this city and in Sacramento of the City and Suburban Water Company, capitalized at $28,000,000, included among the purposes of which is the supplying of domestic water to counties, cities, townships and villages throughout the State of California. The directors of the company are R. Rothschild, G. Cohen, F. Kaiser, J. Reid, J. Stewart, W. Fisher and A. Greene, all of whom reside in San Francisco.

TRANSMISSION.

TACOMA, WASH.—The contract to construct the first unit of the city's Nisqually power plant at Le Grande on the Nisqually river, 30 miles from Tacoma, went to Wright, Sweeney & Cummings for their bid of $655,225.

SPOKANE, WASH.—An application has been filed for a power site on the Kettle river, near Orient, by H. L. Moody of this city and J. L. Leeper of Orient. The site will be developed to furnish electricity for municipal users.

MEDFORD, ORE.—The Condor Light and Power Company, of which Dr. C. R. Ray is manager, has been bought by the Byllesby Company of Chicago. This firm operates several light and power plants and will expend over $250,000 this spring for improvements.

CELILO, ORE.—E. G. Ammie, contracting engineer, Beck building, Portland, has been employed by the Celilo Milling and Power Company (J. W. Griesse, Board of Trade, and C. L. Daggett) to design a power plant on the Columbia river at Celilo Falls to develop from 15,000 to 20,000 horsepower.

LOS ANGELES, CAL.—C. J. Curtis, president of the Los Angeles Dock and Terminal Company, announces the immediate building of a $2,000,000 power plant at Long Beach by the Edison Electric Company. The plant will be a steam generating one and have 30,000 horsepower.

TRANSPORTATION.

SANTA ROSA.—It is reported that the Petaluma and Santa Rosa Railroad will shortly be extended to Guerneville.

SACRAMENTO, CAL.—Sealed bids have been received by the Board of Trustees for the sale of a franchise to construct, maintain and operate a street railway in the city of Sacramento, Cal.

SANTA BARBARA, CAL.—The City Council has passed an ordinance granting to the Santa Barbara Consolidated Company a street railway franchise for a term of 25 years for the construction and maintenance of an electric street railway in this city.

SACRAMENTO, CAL.—An agreement has practically been reached between the Northern Electric Railroad Company, interested property owners and D. W. Carmichael whereby the electric line will build a branch from a point a little west of Ben Ali, on the other side of the American river, into Fair Oaks.

LOS ANGELES, CAL.—The Pacific Electric Redondo line and the Los Angeles Railway will in the near future erect a plant for the building of all the electric cars for the use of the allied Huntington interests in Southern California. This plant will be in Los Angeles and will be, when completed, in a position to build and assemble cars faster than they can be built and delivered by Eastern concerns.

LOS ANGELES, CAL.—The City Council has passed an ordinance granting to Edwards & Wildey the right to construct and for a period of 21 years to operate and maintain a double-track electric street railway upon a portion of a street commencing at the intersection of Heliotrope drive and Melrose avenue, thence westerly over and along Melrose avenue to Normandie street.

NEW WESTMINSTER, B. C.—The British Columbia Electric Railway Company has awarded a contract to the International Contract Company, Central building, Seattle, for the construction of two steel towers 190 feet in height to carry the high potential wires across the Fraser river. The steel has been ordered from the Canada Foundry Company of Toronto.

PROFESSIONAL DIRECTORY

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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JOURNAL OF ELECTRICITY
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VOLUME XXIV | SAN FRANCISCO, MARCH 26, 1910. | NUMBER 13

THE STORY OF THE NEVADA POWER PLANT

BY ARCHIE RICE.

Archie Rice

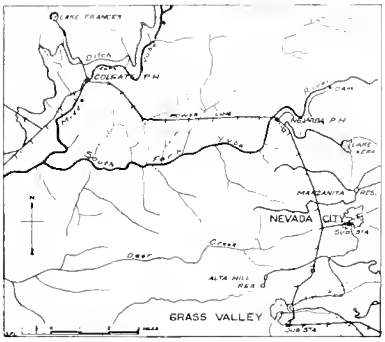
In the heart of mountainous Nevada County, where the miners' outlook is upon a green, corrugated world of Sierra ridges, tumbling up half a mile from the depths of winding canyons that carry the snow-water from the summits down toward the distant sea, there is a little hydro-electric plant, hidden at the bottom of a gorge and clinging just above the high-water mark of the South Yuba River.

There it has stood since the pioneering and experimental period of long-distance transmission of electric energy, and for the past thirteen years has continued constantly generating the subtle current and sending it five miles to the mines and homes of Nevada City and on three miles further to the mines and homes of Grass Valley.

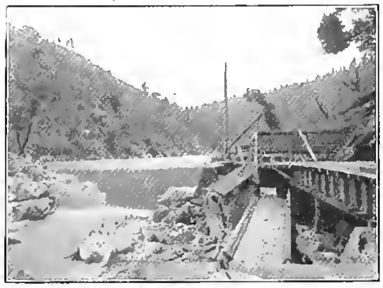
Small, as measured by the standard of the gigantic plants of a later day, and comparatively more expensive of operation than those producing on a larger scale, this early arrival upon the scene of California's electrical development has gone on all these years generating night and day an average of 800 kw., a product, if measured at once cent a kilowatt-hour, representing earnings of nearly $1,000,000.

The South Yuba and the Mountain-side Flume from the Dam 3.1 miles Up-river.

Apart from the interest attaching to this installation in connection with the electrical development of a large number of rich mines on the mother lode, in the greatest gold-producing county in the Golden State, this Nevada power plant has a peculiar historical interest, because it was the nucleus of the Nevada County Power Company, which was conceived in 1891 and later (September 1, 1900) combined with the Yuba



Map of Nevada County, Cal.



The River Dam and Headgate of the Flume in 1895.

Constructing the Flume for the River Dam in 1895

Power Company to form the beginning of the Bay Counties Power Company, that grew until (March 1, 1903) its possessions, with others, were merged into the California Gas and Electric Corporation, a great system which (January 2, 1906) came under the control of a still more comprehensive concern, the Pacific Gas and Electric Company of today.

The creation of that earliest plant, based upon the principle of generating power produced by water diverted from a river and then led to a point where it would fall from a great height, was the idea of Eugene J. de Sabla Jr., a name associated intimately with many of the big hydro-electric enterprises of California.

"I owned some mining interests at Nevada City," he explained, "and I started by trying to get electric power for use in the mines. The problem was to take water by ditch from the South Yuba and, by a gradient less than the river's, carry it down to some point where a sufficient fall could be secured to operate electric generators. Land and water rights were acquired, plans made for the undertaking, a site selected for a dam, and, some three miles further down stream, a spot chosen for a power house at a point on the river about 1,500 ft. above the level of the ocean.

"But it's a joke—the calling of that little plant the 'Rome' power house. It is the Nevada power house. The nickname came about in this way: Romulus R. Colgate was associated with me later in establishing the plant at Colgate, over on the Middle Yuba. After that big one had been named for him, some of us got to referring to the little fellow over on the South Yuba as the 'Rome' power plant, 'Rome' being the familiar shortening of Colgate's first name."

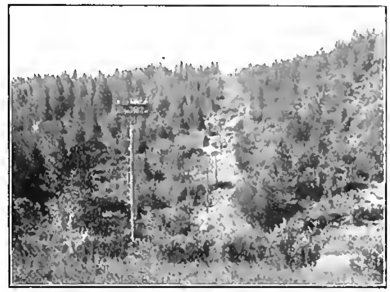
The inception of the Nevada plant on the South Yuba dates back to 1891, when an effort was first made by de Sabla's proposed Nevada County Electric Power Company to put a dam across the river and prepare for a ditch and flume system. But in the spring of 1892 this original dam of logs was swept away by the fury of the flood waters.

With E. J. de Sabla Jr. as manager of the company and Alfred Tredgido as its superintendent another dam was started August 1, 1895, and it was completed November 20th. This dam was of logs piled crib-fashion, and it was bolted firmly down to bedrock in the river. It was 28 ft. high and measured 107 ft. across the crest from bank to bank at that point in the canyon. Before the cribs could be filled with rock and gravel ballast the river began rapidly rising, and the men had to abandon the work. Fortunately the "slickens" washed down from hydraulic mining districts formed so material a part of the turbid stream that every chink and cranny of the crib-work was soon packed solid with a deposit that made the dam more substantial than if it had been filled by man. Work on the flume for this dam had been started July 6th, and it was completed November 28th. The flume itself was made 6 ft. wide and 4½ ft. deep, and its construction took a force of 110 men working nearly four months and using 1,250,000 ft. of lumber. The grade was equivalent to a drop of 26 2-3 ft to the mile, and the distance traversed was 3.1 miles. Through this flume a constant flow of 5,800 miner's inches was to be delivered into a steel pipe, 3 ft. in diameter and 298 ft. long, down the final slope for an actual perpendicular fall of 190 ft. to the wheels. That was the full supply of water to the power house for the first two years of its operation. During October of 1896 Alfred Tredgido was succeeded as superintendent by L. M. Hancock. March 1, 1898, a crib dam 54 ft. high and 356 ft. across the crest from bank to bank was started in Rock Creek to back water up into a partially ex-

Lake Vera in the Formative Period, Looking Eastward From the Dam and Showing John Martin in the Foreground.

The Ditch Flowing into Lake Vera bringing Water from the Deer Creek Power House

Constructing the Lake Vera Dam in 1898



The Original Pole Line as built in 1895

cavated basin that had formerly been the scene of hydraulic diggings. It was completed November 27th. This reservoir area of about 42 acres was then named Lake Vera, for one of E. J. de Sabla's little daughters. Lake Vera had a storage capacity sufficient to furnish a constant flow of 1,000 miner's inches for a period of 30 days. A viaduct was constructed from this lake to convey water a distance of 2¾ miles through 2,340 ft. of flume and 11,404 ft. of ditch (most of it an old mining ditch) to a small forebay, on the hillside 1,870 ft. from the Nevada power house and 785 ft. above it perpendicularly. From this forebay the water shot down through a 20-in. steel pipe to additional impulse wheels installed in the same building with those originally established. After the acquisition of the Lake Vera source the 190-ft. fall secured through the flume from the dam on the South Yuba was called the low-head; and the 785-ft. drop produced by the viaduct from Lake Vera, the high-head.

While the low-head flume is supplied chiefly from the river dam, it receives a supplementary flow from another ditch that takes water out of the South Yuba 50 or 60 miles further up-stream. The high-head supply of water by way of Lake Vera comes indirectly from an enormous watershed catchment area of 121 square miles of Sierra slopes and snow-capped peaks in the region northward of the Southern Pacific railroad between Emigrant Gap and Summit. A series of 24 storage reservoirs, holding an aggregate of more than 2,000,000,000 cubic ft. of water, conserves the melting snows and the mountain rivulets of that vast area and forms the source of what is known as the Pacific Gas and Electric Company's South Yuba water system of 450 miles of viaducts. Part of the product in these 24 reservoirs is conveyed to the Auburn side of the ridge, and is carried off down that way as a great irrigating system for 13,000 acres of hillside orchards. The other part is conveyed toward Nevada City and Grass Valley for domestic and irrigating purposes in that region. This Grass Valley water supply comes down from Emigrant Gap through Main ditch, Chalk Bluff ditch, Cascade ditch and Snow Mountain ditch, and first forms the motive power for the company's Deer Creek power plant, which is at an altitude of 3,500 ft. After driving the Deer Creek impulse wheels, part of the flow is carried on several miles by ditch to form the main source for Lake Vera, which has a very small natural catchment.

With the creation of the high-head supply from Lake Vera it was no longer necessary to maintain the low-head flow at the original maximum of 5,800 miner's inches, so the flume capacity from the river dam was reduced to 3,800 miner's inches, which is now its normal flow.

While the Lake Vera dam was being constructed in 1898 the flume and ditch leading from it were also made ready. This flume is 3½ ft. deep by 4 ft. wide, and has a gradient so gradual that the water takes an hour and five minutes to run from Lake Vera, a distance of 2¾ miles, to the small forebay above the power house. About two-thirds of the way from the lake to the lower end of the ditch is Myer's Ravine, a big gorge, across which the water is conveyed in an inverted, or U-shaped, syphon, a 36-in. pipe 668 ft. long, that crosses the canyon and connects the separated ends of the flume.

In July of 1900 George Scarfe succeeded L. M. Hancock as superintendent of the Nevada power plant, and, excepting one year, he has been the superintendent of that power division ever since.

April 2, 1905, a part of the Lake Vera dam, 29x30 ft., gave way and permitted an outflow that dropped the water level at the rate of an inch a minute. When the break occurred the depth of water in the lake was 52 ft. A force of men was rushed to the work of repair, and the gap was closed with wood and cement. The dam is now but 40 ft. high, and the storage capacity of the lake is equivalent to a constant flow of 1,000 miner's inches of water for only ten days instead of thirty.

In 1908 the original crib dam three miles upstream on the South Yuba was substantially fortified with a granite wall on the down-stream face, 12 ft.

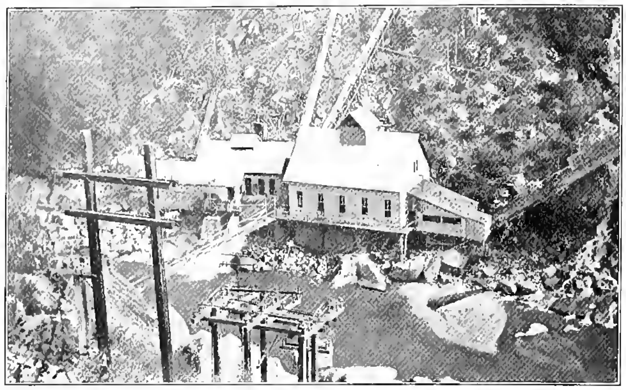
The River Dam as It Looks To-Day With Its Heavy Facing of Granite.

thick at the base and tapering to a thickness of 2 ft. at the top.

So much for the water power and its sources and channels.

As a business proposition the enterprise started under the name of the Nevada County Electric Power Company. The contract for the construction of the dam, flume and power house was given to John Martin, a name that in a few years was also to become widely identified with mammoth hydro-electric generating enterprises in California. The great installations that he and de Sabla created are all now owned by the Pacific Gas and Electric Company. The actual supervision of the construction of the dam and the flume was left to Alfred Tredgido, who became the Nevada County company's first operating superintendent.

While John Martin was harnessing the South Yuba for this power, Eugene J. de Sabla Jr. was busy in the Nevada City and Grass Valley mining districts interesting mine owners for the purpose of securing consumers for the proposed load. Many of the mine managers were skeptical as to the efficiency and practicability of this prospective transmitted river power, and during the first year of operation there were but few customers among the mines. The W. Y. O. D., the Homeward Bound and the Gold Hill mines in the Nevada district were the first to use the power, and they were followed by the Pennsylvania, the Brunswick, the Allison Ranch, and the North Star in the Grass Valley district, and then by the Mountaineer in the Nevada district. But no mine that installed a motor to take this electric power ever abandoned its use unless the mine itself was closed for some other reason. All that the enthusiastic de Sabla had promised came true. Those earliest installed electric machines are still doing the work in the mines.



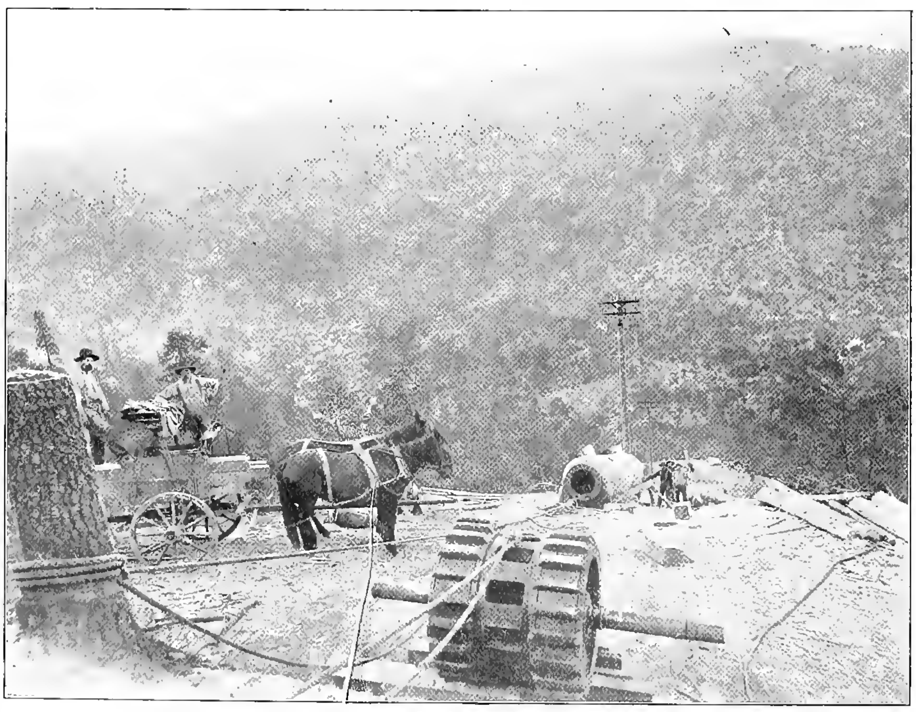
The Nevada Power House on the South Yuba River.

The roads of Nevada County climb and dive and climb and dive again over ridges and through forests. They were built in the early mining days on the principle of "get there quick," without any attention to easy gradients or future permanence, and the same old roads have continued in use with little improvement in grades.

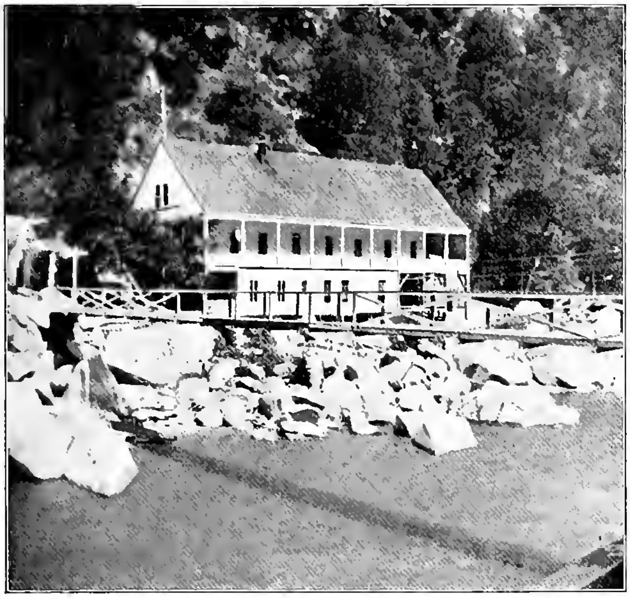
All the machinery for the Nevada power plant had to go by rail to Colfax, and thence on the little Nevada County Narrow Gauge Railroad across ridges and ravines to Nevada City. From there the problem was to get it to the site selected for the plant. The old wagon road for a distance of about three miles had to be widened in places and improved. It was all up grade. A stretch of nearly two miles of new road had to be built up to the top of a ridge through underbrush, cactus, small pines and scrub oak and it was hard work.

Big teams, many of them 12-horse, were used to haul the heavy pieces of machinery up to the top of the "slide," 1,700 ft. elevation above, and half a mile from the site of the plant. Each generator weighed 11,200 pounds, and that was some weight to pull all that way up to the top of the ridge, just beyond the crest of which the loads were deposited.

Hauling Machinery to Power House in 1865



Where the Massive Machinery was Unloaded at the Top of the Ridge to be Skidded Down half a Mile.



The Boarding House.

Then began the tug-of-war with men and heavy hawsers and stout cables cautiously sliding the valuable machinery down hill on skids mounted on log rollers, while big tree stumps served as capstans, from round which slowly to pay out the rope and lower away the load. The first 400 ft. down was by wagon. Then came the lowering by cables—400 ft. at an angle of 25 degrees, 600 ft. at an angle of 32 degrees, 80 ft. at an angle of 35 degrees, and finally 220 ft. at an angle of 39 degrees. In this laborious fashion the machinery was delivered to the narrow ledge that had been scooped off at the edge of the river, down in the bottom of the V-shaped canyon.

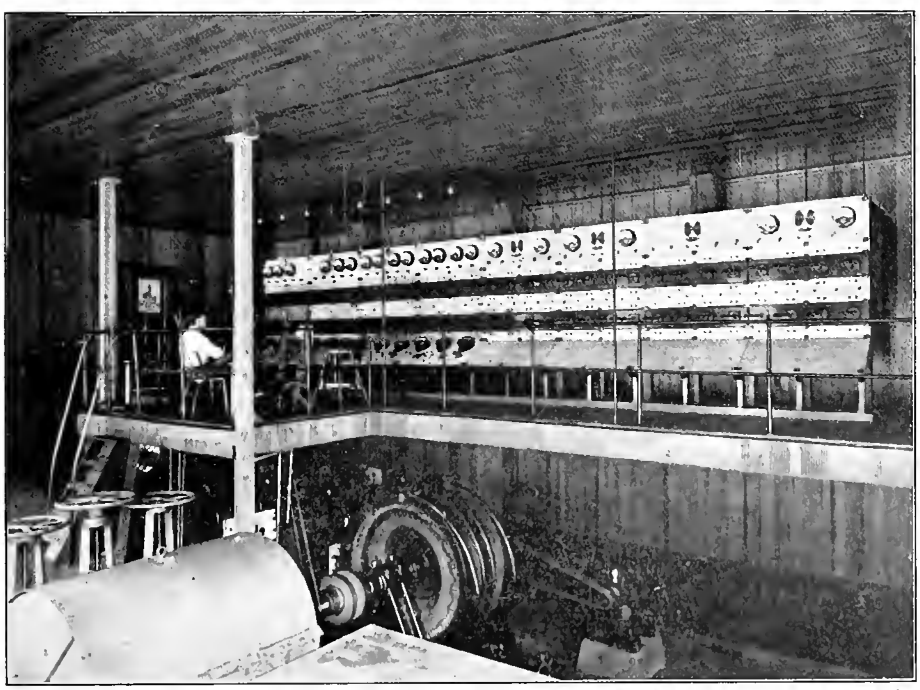
No plant could have been crowded into more cramped quarters than that Nevada power house and its boarding house. Each is hugging the river bank and backed into the wall of the canyon so tightly that they had to be placed on opposite sides of the stream, with a suspension bridge connecting them across the river itself. The rushing river water is their front yard, and there is no back yard.

The power house foundations are on solid bedrock granite. Steel rods ¾ in. thick are sulphured down into the virgin rock, and they rise perpendicularly through a bed of 18-in. solid concrete and come on up through heavy timbers to which they are bolted. Upon massive beams thus firmly secured rests the generating machinery.

Despite all the physical difficulties of the site, not a single mishap or delay occurred in the installation of that plant.

Along the last and steepest part of the "slide" the water pipes had to be laid and anchored to make them secure for the function of carrying the flume water swiftly down to drive the impulse wheels. As first installed, the low-head pipe went down in diminishing sizes to increase the density of the final jet. For the first 120 ft. the pipe diameter was 48 in.; for the next 100 ft., 44 in.; and for the last 100 ft., 42 in. This pipe discharged into a large steel receiver from which the water shot against the wheels.

For the original installation there were two 300 kw., 133-cycle, two-phase, Stanley, inductor-type generators, making 400 r.p.m., and generating at 5,500 volts. Each was direct-connected to 3-ft. Pelton impulse wheels. Three of these Pelton wheels were used on one generator and four on the other. The generators were guaranteed to have a commercial efficiency of 94.6 per cent and an electric efficiency of 98 per cent. Each of the seven Pelton wheels had two nozzles, and the two generators together developed about 800 h.p. The first switchboard consisted of open-air, automatic circuit breakers. They were supposed to break the circuit, but, as George Scarfe relates, "they did not always do it, and at times there were many displays of fireworks." But the deficiences of the equipment in those early days of hydro-electric generation have taught lessons that have been the means of producing many of the improvements and economies introduced into the plants later established. From the switchboard the two-phase lines were carried out through the end of a power house to an 8-mile pole-line ending at Grass Valley and having a midway branch to Nevada City. This pole-line was



The Switchboard in the Newer Part of the Power House.

run up hill and down in a right-of-way cleared 60 ft. wide through a brushy and timbered country. Round poles, cut from the right-of-way and reaching 30 ft. above the ground, were used, and on them were crossarms with triple-petticoat, white porcelain insulators, manufactured by the Locke Company. These insulators are still in use, but the poles and crossarms have all been renewed.

When the power plant was being built Grass Valley and Nevada City were electric-lighted by a series system from a small plant owned by K. Caspar, now proprietor of an electric-lighting system in Vallejo. The Caspar plant was bought by the new Nevada County Electric Power Company, and a sub-station established in Grass Valley and one in Nevada City. Step-down transformers were placed in these sub-stations to reduce the 5,500-volt current from the new Nevada hydro-electric plant on the South Yuba to a voltage of 2,200 for use in the mines. The small house transformers stepped-down this 2,200-volt current to a 550-volt current for small motors used in a foundry and in a planing mill, and further transformed it to a 110-volt current for city and domestic lighting.

The original installation proved so successful that demands began to be made for more capacity. Then it was that the Lake Vera dam was built and the high-head water power secured as a supplementary supply for the Nevada power house. To make use of this new supply of water, a corrugated iron building was erected in 1898-99 next to the original power house, and Tutthill water-wheels were installed to operate two more Stanley generators of the same size and description as the original two. These new generators each developed 330 kw. The high-head wheels were mounted on the same shaft as the low-head wheels that got their impulse from the river flume. A switchboard, with Martin open-air switches, was put in the new building so that all the machines could be operated in parallel.

When, in 1900, still more power was demanded, arrangements were made with the Yuba Power Company's plant at Colgate (now also the property of the Pacific Gas and Electric Company) by which a 23,000-volt current was brought over the ridges to Grass Valley, where four 200 kw. transformers were installed to lower the voltage from 23,000 to 5,500, so that it could be combined with the initial power from the Nevada plant. At that time 23,000 volts was high power to be sent over a mountainous district frequented in winter by heavy snowfall, and the old-time electric men used to go out at night occasionally and watch apprehensively to see how the insulators would endure under the coating of snowflakes.

In March of 1907, according to C. Boyd, its present foreman, the little Nevada plant held out through a terrific rainstorm that shut down all the other hydro-electric plants of the system. At no other station is there to be found greater pride in their plant than exists among the employees hidden down in that narrow canyon at the place they affectionately call "the 'Rome' power house," whose average production of 1200 kw. is small as compared with Colgate's 19,000 h.p. and Electra's 26,000 h.p.

THE PUBLIC SERVICE CORPORATION.[1]

BY C. L. CORY.

The original reason for the selection of this subject is because of my conviction that such matters as the public service corporation and the people, and social matters generally, are becoming now of as much importance to the engineer in the practice of his profession as, perhaps, the technical side of his labors; and there are a number of things that are perhaps of more importance just at the present time than they have been heretofore; and as I say, it was perhaps with that in mind that I first gave some thought to the subject of public service corporations as a proper subject to be seriously considered by engineers, and one which might well be followed up seriously by them.

Just as soon as I began to think seriously about the paper I could not but recall an incident not very many years ago when at a university not very far away, President McKinley was to be the main speaker, and, due to the illness of Mrs. McKinley, it was impossible for him to attend the commencement exercises of this university. As his substitute John Hay, then Secretary of State, was the principal speaker of the occasion; but on the program there were certain graduates who were to speak, and among the number was a young man (who now happens to be a judge of the Superior Court in one of the three largest counties of California) whose oration was on the subject of international law. When the members of the faculty who had charge of the arrangements for the day read this young man's address, they found it was about an hour long; so they said to him, that inasmuch as John Hay was to be the principal speaker, and especially as his subject was international law, it might be well for him to cut down his address to about five or ten minutes. That was agreed, but, notwithstanding, when the addresses were being made, this young man having first opportunity, he did not stop at the expiration of his ten minutes, and Mr. Hay had the high pleasure of listening to a learned discourse by a university graduate on international law. Later, and in a few concise words, those of us who were fortunate enough to be present had the pleasure of listening to some of the elementary principles of international law explained very clearly, and the contrast was of course marked.

I felt a little like that when I began to think of the subject of public service corporations; and it is only my intention, if I can do it, to confine myself to five or ten minutes.

In presenting a paper before the Institute treating on some phases of the public service corporation, I may say that in my opinion it is desirable that engineers should give serious thought to some of the problems inseparably connected with the subject, even at the expense of some neglect of purely technical matters. In the past twenty years great progress has been made in science and engineering. The present state of engineering development is due to the combined work of many minds. At the present time we may at least assume certain high standards have been

[1]Paper read before San Francisco Section of American Institute of Electrical Engineers, February 25, 1910.

unquestionably established, especially those of a purely technical achievement. Just now the situation deserves a little different treatment, and the engineers of today should be as well equipped to join in the solution of social problems as the men belonging to other professions. It is eminently proper, therefore, for engineers to take up serious subjects that are not necessarily technical, but which have a definite relation to any development, the success of which is based in part upon the highest technical consideration.

One essential difference between man and the lower animal lies in the fact that the former finds it necessary for him to serve his fellows to obtain the necessities, and sometimes, in addition, the luxuries of life, while, in contrast, the adult undomesticated animal has little else to do than to individually exist, and in some way for himself alone, obtain sufficient food to live.

Man must be a member of society whether he will or no, and in the present complex civilization his efforts can best be confined largely to the giving of his time to others. To serve as a slave is degrading, but in loyal and conscientious service one may give his best efforts and in the end rest assured that he will be appreciated and receive his due reward. Service to others is an absolute requirement for real success and applies to everyone. It is, of course, necessary to exclude the old and infirm, the sick, the mentally deficient, as well as idiots, and it is remarkable how many kinds of the latter there really are. The king as well as the peasant, the rich as well as the poor, the high as well as the low, all must, of necessity, if they really live, serve others. This service is, of course, of a different character in many cases, but there is no question but that one is truly estimated by the extent of their service, not for themselves, but for others. Every individual, whoever he or she may be, who covets name and fame; yes, even wealth, must sooner or later adopt this principle as a guiding factor in their conduct, and the degree of intelligence, industry, integrity and loyalty exhibited by the individual in such service will be a true measure of the ultimate success attained.

What is true of the individual is similarly true of a combination of individuals, who are joined together for the attainment of some particular thing which is impossible by a single individual. Therefore the principle applies as fully to what is generally known as the corporation, or in this special case, the public service corporation, as to the individual. The service desired by the many must be furnished by the one, and where the demand exists and is fully supplied, there is the greatest opportunity for competent and effective effort.

Just as some people succeed, it may be said that some corporations succeed, and as some people fail, so some corporations fall far short of real success. That corporation which has for its main and only object the making of money regardless of the quality of service rendered is as much a menace to mankind as the workman who works only for dollars and takes no interest in his work or in overcoming the difficulties which are constantly brought to his attention. Any man who would succeed must look to his daily work as a part of his life and at least obtain a certain amount of gratification by doing his work well; if possible, better than any other one could do it, and not have his mind completely absorbed in the contemplation of the compensation which from his standpoint should come to him. It would seem therefore that the public service corporation should have a broad point of view, and those responsible for their guidance should remember that they are a large part of the activity in the community which they serve, and that it is just as possible for them to be a material factor in progress as it is for the capable individual to do his share in improving the conditions surrounding him and his fellows.

We have come to think, and it is unquestionably true, that the large corporation is a necessity because no person could as an individual carry to a successful conclusion the great systems of construction and development work required to adequately provide all the service that is so consistently demanded at the present time and covered only in part by facilities for transportation, methods of communication and the furnishing of water, light and power service, as well as many other of the necessities, conveniences and even luxuries of life.

The corporations which provide such service come into immediate contact with the people and their representatives. To a group of engineers, then, the consideration of a few problems of importance to the people, and at the same time to the public service corporations, is a vital matter to them, since it is in the direct or indirect service of such corporations that many of us have our real opportunities.

We all know of the difficulties which have been developing and are becoming more and more serious in recent years regarding the rights of the people who are the customers and the real or legal rights of such public service corporations. From every standpoint I maintain that their interests are mutual, and that anything which affects the one affects the other, and that any serious investigation which is made should be so considered. Unfortunately many matters pertaining to the existence and conduct of the public service corporations have been treated and considered inadequately by the people through their representatives. The reasons for this inadequate, and sometimes even farcial, consideration of such matters are not difficult to find. They are real reasons of importance, and it is not my intention to minimize them. On the contrary, in this brief paper I wish to invite your attention to a few things of interest, as they really exist, to the public service corporations as well as their customers, the people. In so doing, no one more than myself appreciates that in all probability, viewed from the standpoint of the law, many things that I may say are justly subject to modification, but I hope at least, from the strictly engineering standpoint, to present for the purpose of discussion some problems in the solution of which the engineer may, in fact, should be, of much service.

One of the most important matters in which the people as well as the public service corporations are interested is in connection with the rates of service. What rights have the people in attempting to control such rates, and, on the other hand, what rights have the public service corporations, and may the latter

consider their property and the operation of the same as something which belongs exclusively to them, and in which there should be no interference whatsoever?

I will not attempt to go into details of the relative rights of the two as above suggested, but it may be said briefly that it has been established by the United States Supreme Court that many public service corporations are subject to investigation by the people in connection with the fixing of rates of service. As a result such investigations are now being made more or less thoroughly by the federal and some state and municipal governments. Public service commissions have been brought into existence, and while the results of their work have not as yet fully demonstrated the probability of ultimate success, yet in many instances the investigations are being made in a thorough and unbiased manner, and such investigations deserve the most hearty co-operation of the real friends of the public service corporations as well as the people.

Unfortunately, however, in the past in many instances attempts have been made to regulate rates by the representatives of the people when these representatives of the people have been entirely incompetent to do such work. It is also true that in many such so-called investigations the proper motive has not guided either the representatives of the people or those in control of the corporations. Such an ulterior motive is usually stigmatized for the one "politics," and for the other "greed," and there is no escaping the unfortunate influence which has resulted from superficial investigations, when the representatives both of the people and the corporations have in reality done nothing but fight for their own individual selfish interests.

It is the practice of engineers to treat conditions as they are and not complain or wish they were otherwise. It is probably just as well, therefore, for us to look into these matters, knowing that in many cases not only are the people unfortunately inadequately represented, but also that many public service corporations deserve as severe criticism on account of their consistent efforts to keep the facts from the public. In order that we may consider some of the present day questions from, if possible, a purely unbiased standpoint, I beg that you give attention to the following necessarily inadequate illustration.

I am frank to say that I gave much consideration to the formulation of a satisfactory illustration to bring out the importance of some of the things that are of special significance to the public service corporation and their customers. What I hoped to do was to be able to bring out in a simpler manner the question of the cost of plant, the investment, the true valuation—perhaps the difference between those expressions; also the cost of operation and the explanation of such terms as repairs, reconstruction, depreciation, obsolescence and terms that are more or less new to the present generation. I am quite sure I haven't succeeded in selecting a very complete illustration, but I think it will be of some help to us to more clearly see the ultimate result which should be attained.

Let us suppose that in the year 1000 a financial institution, such as a bank or trust company, among its other holdings, owned a comparatively small manufacturing plant for the purpose of making ready-made clothing, and for good reasons this manufacturing plant is located a number of miles, say twenty, from a city. This plant is to be supplied with transportation for material and employees between city and factory. Also the factory is to be furnished with an adequate water supply, gas, electric light, power and telephone service. The financial institution, having other use for its funds, and not being in the transportation business, nor the supplying of water, gas, electric light and power and telephone service, does not wish to make the investments necessary to furnish their factory with the service required. As a consequence it agrees with a single individual to provide all these classes of service with the distinct understanding that the individual is to be paid such rates for the service rendered as will cover all proper operating expenses, and in addition, allow a certain return upon the investment required. Further, the methods of keeping accounts are entirely under the control of the trust company, and let us in addition make the reasonable assumption that both parties to the agreement are honest in their intentions and efforts to do what is right.

Let us consider the matter of transportation. A private right of way is provided by the trust company and properly graded and macadamized. Probably in the year 1000 the individual undertaking such transportation would have decided that the automobile would be better to use than the horse, the use of an electric or other railway being eliminated solely for the purpose of our illustration.

When the time comes to adjust the rates of service, I think that we will agree that the first thing for both parties to obtain is a reasonably correct inventory of the entire equipment necessary to provide such transportation, and, second, determine its cost or proper valuation, since it is upon some such valuation that an adequate return upon the investment must be allowed.

I had in mind in the choosing of the private right of way something in the nature of a franchise. How would the individual who is giving this service continue to do so unless he were given the property of the trust company along the highway, properly graded? The use of that highway is granted as a part, if you like, of the agreement to provide the transportation service.

To contrast what is a fact in many cases where the rates of the public service corporation are supposed to be fixed by the people, what chance would the trust company and the other party to the agreement, the individual, have of agreeing upon the rates of service if the former maintained that the equipment of automobiles was worth but $25,000, and the individual should maintain that the proper valuation to place upon the equipment was $50,000? Who is to make or attempt to determine the proper valuation for rate fixing purposes? There can be no question but that it must be done by someone in some manner. As engineers we would say that such a valuation could be arrived at best by a commission or com-

mittee, the members of which are properly qualified to understand the details of the business. It should not be impossible to obtain reasonably accurate figures if sufficient time is taken and the work is done by competent people. A number of questions will undoubtedly arise as to the proper interpretation of the word "valuation." For instance, are the automobiles to be valued today at what they cost ten years ago, or what it will cost to replace them now? I have purposely selected the automobile as the means of transportation because during the past ten years the state of the art and the manufacture of automobiles has greatly advanced, as has the equipment of many public service corporations in even a shorter time. This and similar questions deserve the most careful consideration and should not be viewed solely from the point of view of the the customer or, in a similar manner, from the point of view of those interested only in the service supplied.

Great confusion certainly exists in the minds of many as to the proper interpretation of such terms as repairs, reconstruction, depreciation, obsolescence, etc. It must be admitted that no absolute definition of many such terms has been universally adopted. It is for this reason that great care is necessary in applying these terms to specific cases. There is, however, a real distinction between depreciation, obsolescence and repairs, and while it is impossible to definitely fix a line of demarkation between them, certain general principles are involved in determining the application of such terms.

Suppose, to return to our illustration, that ten years ago the individual who had started the transportation system purchased the best automobiles made at that time. During their use it is certain that some money would have been required to buy new tires, repair broken parts and in general keep the automobiles in good running condition, particularly as satisfactory transportation must be provided even during the worst weather and under extremely adverse circumstances. It undoubtedly would have been necessary to have reconstructed many parts of these automobiles. With all such repairs and reconstruction, however, it is quite improbable that today any one of these automobiles would be in use. No matter how good service they may have given, it would have been necessary to have entirely discarded them and to have purchased machines of a more modern type, not because they could not be used at all, and reasonably good service provided, but because the actual cost of operation would be materially reduced by taking the old type of machines out and replacing them with more modern and probably larger ones of the present day.

From one point of view a proper interpretation of the terms depreciation and obsolescence may be understood by the consideration of these old-style automobiles. All possible repairs and reconstruction, as from time to time required, was done to these old machines. Nevertheless, during the ten-year period, or perhaps even a less time, they became so far out of date and inadequate that it was necessary to discard them and replace them with new machines. It would have been unfortunate indeed for the individual providing the means of transportation if he had not had in mind each year during this ten-year period the time when such new machines must be purchased to replace the old, and probably the most satisfactory way would have been to have set aside each year a certain sum as a depreciation account which was to be used when needed to purchase the new equipment. It would probably be very difficult in the start to estimate accurately, without considerable experience, how long the old machines would be capable of use, or to put it another way, what would be the proper per cent allowance to be included in the total annual cost of operation for depreciation, obsolescence, etc. Experience and knowledge in such matters, when applied honestly to the different portions of any system, should give results not far from ultimate requirements. It is of the greatest importance, however, to segregate accounts so that the cost of repairs, both detail and general, do not overlap or be confused with depreciation or obsolescence accounts.

Carrying the illustration one step further, let us suppose that the trust company wishes the agreement, wherein they are provided the various services above enumerated, to continue in force for a period of fifty years. Let us suppose that in 1900 the output of the factory was not greater than 10,000 suits per year. During the ten years from 1900 to 1910 the factory has grown so that the output is now 100,000 suits per year, and that during the remaining forty years covered by the agreement, there will be continued growth at a rate, maybe less or perhaps greater, than during the first ten-year period.

As the factory has increased its output ten times, it will have been necessary for the individual to have increased the investment in his transportation, water supply, electric light and power and telephone service. Referring to the transportation system only, let us suppose that the net earnings have been $10,000 per year, but that due to the growth of the manufacturing plant it has been necessary for him each year to add new automobiles costing $20,000. Should not the return or percentage allowed upon the investment be affected somewhat by the continued increase in the amount of investment necessary to supply satisfactory transportation service?

Here we have a situation which is readily compared with that of many public service corporations. Notwithstanding the fact that what is usually termed a reasonable return upon the investment is assured and also that they may be in exclusive control of the service required, yet each and every year in order to keep pace with the increased demand for additional service, an increased investment is required equal in amount to twice the net earnings. The rapid growth of American cities and communities has developed many such instances in the development and operation of public service corporations.

Again let us suppose that during this ten-year period just ended, instead of the individual having the exclusive right of furnishing transportation, water, gas, electric light and power and telephone service, as a result of the rapid growth of the manufacturing plant he had been compelled to continually provide against possible competition, which, if allowed, would have divided the gross receipts between himself and one or more others. It is quite apparent that if the

trust company allows a reasonable return upon duplicate investments there can be no question but that the introduction of a second or competing system will result in increased payments by the trust company, and as long as the party to the original agreement provides adequate facilities for the constantly increasing demands, the fixed charges and operating expenses should be less with the one system than with two or more independent ones, since the trust company is really paying such rates as will give an adequate return upon the investment.

Again, suppose the individual is desirous of selling out his transportation business to another who undertakes to fulfill the original agreement. Shall the exclusive privilege to use the private right of way provided by the trust company be considered of something of definite value, and therefore properly included in the investment required by the transportation system in the determining of proper rates? The exclusive use of the highway by the individual covering a period of fifty years might be considered as a franchise. Originally it was provided to the individual free of all expense to him. Should he, in turning over his assets to his successor, use this exclusive privilege as an asset of fixed value, and expect the purchaser to include in the purchase price an agreed sum for the privilege, or for rate fixing purposes should the exclusive use of the highway owned entirely by the trust company be capitalized and included in the valuation agreed upon for rate fixing purposes? In the beginning of the agreement with the small manufacturing plant, the exclusive use of the highway might have been of little value, but when the plant has increased its output tenfold in as many years the exclusive privilege or franchise may have, and in all probability has, greatly increased in value.

Unfortunately when we turn from the above illustration and consider the people on the one hand and the public service corporation on the other, we do not usually find the hearty co-operation which was assumed a necessary part of the agreement between the financial institution and the individual to whom was entrusted the supplying of the required service. The fact is that the people as a rule are as suspicious of public service corporations as the latter are suspicious of the so-called representatives of the people. It is much easier to enumerate the many difficulties than to suggest remedies to improve the conditions existing. In this brief discussion I will not attempt to enumerate the many reasons for the lack of confidence between the people and the public service corporation. Suffice it to say that the methods of investigation which are common in connection with rate fixing in many instances are not only misleading, but are so superficial as to lead to absolutely no definite results. On the other hand, the methods of financing public service corporations, involving the issue of bonds and different class of stock, on a purely speculative rather than investment basis, tends to develop a lack of confidence on the part of the people, which is not at all surprising.

In conclusion I beg to offer a few suggestions which may be readily inferred from the above discussion.

If it has been judicially established that the people have a right to adjust rates of service, one of the first things to do is to obtain a proper appraisement of the plant from which the amount of the required investment may be derived, with the ultimate end of obtaining a figure which shall at least approximately represent the proper valuation for rate fixing purposes. Where possible competition, by virtue of the circumstances, must be constantly kept in mind, the investment necessary may properly include unused parts of the plant or certain property, the acquisition of which by an opposition company would seriously jeopardize the earning capacity of the first.

In determining the proper valuation for rate fixing purposes adequate loading charges should be added when the inventory and unit costs include only the first or original cost of materials and labor. Such loading charges, if the work is not all done at one time, may quite properly include a percentage for piecemeal construction, and may always include a proper allowance for engineering and supervision, casualty insurance, interest during construction and similar items properly compounded. I am quite aware that it is not an easy matter to accurately determine the proper percentages indicated above, but, nevertheless, I am of the opinion that the consideration of such so-called loading charges will in any specific instance very materially assist in obtaining the proper valuation upon which a return upon the investments is to be allowed.

Depreciation charges should be included in estimating the annual cost of operation. The greatest care must, however, be taken in properly determining the amount of such depreciation charges, and the different parts of the plant should be considered separately in obtaining the average depreciation for the entire equipment.

Many public service corporations are natural monopolies and no amount of competition in such cases can improve conditions or provide cheaper or improved services to customers. For such, viewed solely from the interests of the people, exclusive rights or franchises should be granted, but only when the most complete and absolute regulation of rates intelligently carried out is included as an integral part of the agreement whereby the sole or exclusive rights or franchises are granted, either for a period or in perpetuity.

The representatives of the people, whether such represent the federal, state or municipal governments, should in a most thorough and complete manner procure all the data necessary to equitably fix the rates of public service corporations, and in so far as possible it would be of advantage if the public service corporations would give to the public detailed information as to the real cost of their systems and the expenses of operation. If this were done the people might appreciate to a large degree the difficulties which must be successfully overcome in order to give good and satisfactory service. Finally, it is quite necessary that the public service corporations give to the representatives of the people every opportunity for them to obtain all the information and data required to, with fairness to all, fix the rates of service.

DISCUSSION ON THE PUBLIC SERVICE CORPORATION.

At the conclusion of C. L. Cory's paper on "The Public Service Corporation" was a discussion in which the following participated:

C. W. Burkett, General Superintendent of Plant, Pacific Telephone and Telegraph Company, San Francisco, Chairman.

John A. Britton, Vice President and General Manager Pacific Gas and Electric Company, San Francisco.

R. B. Daggett, Daggett, Reed & Co., San Francisco.

A. H. Halloran, Managing Editor Journal of Electricity, Power and Gas.

W. A. Hillebrand, Instructor in Electrical Engineering, Stanford University, California.

H. T. Cory, California Development Company.

W. H. Seaver, Pacific Coast sales agent American Steel and Wire Company, San Francisco.

George C. Holberton, Manager San Francisco Gas and Electric Company.

M. M. Libby.

C. L. Cory, Professor of Electrical Engineering, University of California.

John A. Britton: I could not forbear coming here when I heard the title of the professor's paper, because I know of nothing else in life except public service corporations, and I have appreciated that it was about time that engineers, classed as such solely, should take up a side of their business other than that which the professor has rightly said is the purely technical side.

The engineers of today have more to do with a consideration of the financial end of the corporations which they serve than they really have with the engineering. They are the influential factors in determining whether an investment will be a profitable one; and, secondarily, they must show the investors that the results of the expenditure of money will be profitable; and to do that they must deal with all of the questions that the professor has brought out in his very able paper tonight.

Public service corporations are of very recent growth. The first public service corporation known was a gas company organized in England in the latter part of the last century. In 1797 the discovery of illuminating gas was first given to the world. That brought about the service of that commodity to the public, and from that grew public service corporations. The railroads were the next that have come in under the cover; then followed the electric light and power interests, and subsequently the telephone.

Public service corporations today, in my judgment, are responsible for all of the contumely heaped upon them by the press and the public. They have nothing but apologies to offer, and they are suffering largely from the sins of their predecessors, and some of them are today suffering from their own disease of corruptness. One corporation having a poor policy can so taint the pure water of the rest that all of the water is bad.

The education of the people and the education of the public needs to come right through the engineering class today. The business man is not a fit one to appear before rate fixing bodies. He is colored too much—his views are in accord with his own desires. The engineer stands between as a factor looking only at the right side of the proposition, having no particular views of his own, and judging from most engineers that I know, possessing no stock and bonds in the corporations they are pleading for, and therefore have no monetary interest excepting their monthly stipend

The question of rate fixing is new also. It began with the adoption of the present constitution of the State of California in 1879. Prior to that time, so far as I have ever been able to learn, in no State in the United States was any attempt ever made to fix rates for any public service corporation. That constitution, as you know, was born in the sandlots in San Francisco; it was practically created by Dennis Kearney, who, through his wonderful magnetism and his wonderful power as an agitator, brought about the question of a new constitution in this State. The constitutional convention was composed probably of the brightest men in the State of California, who were at that time impressed not only by the press of the country and of San Francisco, but by the attitude of the people themselves, with the necessity for some reform measures against the corporations which had up to that time been dominating the State of California. So the action of the constitutional convention was more or less drastic in its character, and the particular provisions in it that are obnoxious today, from a fair point of view, were the direct result of the attitude of corporations towards the public at that time.

The rate-fixing was particularly directed to the water companies of the State. There was one provision inserted, Article 11 of Section 19, which provided that anyone could occupy the streets of any city or incorporated town in the State of California free of any franchise privilege for the purpose of laying conduits for supplying the inhabitants "with gas-light or other artificial light," electricity, of course, at that time being an unknown quantity; and giving that privilege with the understanding, as stated, that the municipality should have the right to fix the rates to be charged for the service. Under that provision of the Constitution—which, by the way, was an amendment of the original constitution, adopted in 1883, the municipalities of California have had the power, sustained by the highest courts of the land, to fix and determine the rates.

Subsequently, possibly four or five years after that, the agitation in the matter of fixing rates began throughout the Eastern States, Massachusetts being the first State to take up that question—Massachusetts, the most conservative State in the Union, a State where investments are safe and where they are protected, went about it in a business-like way and instituted a gas and electric light commission, which has existed ever since, and whose decisions have never been disturbed, and whose justice has never been contradicted. It stands as a monument of all rate-fixing matters, as the only basis on which justice can be done to the public and to the corporations. You know, possibly, it has been followed in Wisconsin and New York since.

Briefly, that is the history of the rate-fixing. Today in California rate-fixing is a farce. Acting upon the authority granted by the Constitution, the several bodies throughout the State summon all the public-service corporations annually before them to render statements, which are as Sanscrit to the men who pass upon them, which contain statements that they cannot understand, and, in nine cases out of ten, that they cannot comprehend; for the man who is earning one hundred dollars a month can't think in millions. Yet the law and the men are not to blame. The law has put that burden upon them to pass upon the rates. They are between the devil and the deep sea. (Whichever of those the corporation is, I don't know.) They solemnly sit there; they listen to the pleadings of the corporation president, or the corporation engineers, on values and revenues and expense. They are none the wiser when they get through. They ask some very intelligent questions occasionally. More often they don't know what to ask, and they perfunctorily pass an ordinance fixing a rate that determines nothing, and the corporations, as a rule, have been forced into the courts, intensifying necessarily the feeling against them, and creating the great unrest that prevails.

The press don't help matters, either, rarely taking the side of the corporation, even if they know the corporation is right. It is not good policy to do that. They are catering to the people, and the attitude of the people today is more or less anarchistic, and they cannot be blamed for it. When wealth is used as it is today, and flaunted in the face of the poor struggling workman, it is no wonder that the public as a class rise

up to smite the man with the money, because they are taught to believe that he could not possibly have come by it honestly.

In fact, David Starr Jordan said, the other day, that he did not believe that any man ever honestly made a million dollars. When you have the president of one of the great universities of the world making an assertion of that kind, how can you blame the ignorant workingman who allies himself against capital, wherther individually held or corporately held? The mission of engineers today should be to go out and preach the gospel of the defense of capital honestly invested, and if they believe in the corporations they could do it. If they do not know that the corporation they are working for is honestly capitalized, and that they are asking only for honest returns on that money, it should be their business to find out from the corporation, advise themselves, and then go out and preach that gospel. For capital needs the same protection that the man working for the corporation needs himself. I am assuming now that corporations are only asking today that amount of revenue which will yield a reasonable return upon the amount of money honestly invested; that it is only asking its expense account, a reasonable amount outside of the known factors that go to make up the actual expense of operation, maintenance and distribution in every business, and that which will constitute the much-troubled question of depreciation.

Engineers will always disagree upon what constitutes depreciation, and I don't believe it ever will be determined except in one way. I think that question could be solved in this manner: Corporations insure the fidelity of their clerks; they insure their property from destruction by fire; they insure themselves against accident to the people in their service. It seems logical to me to follow out that idea, that there should be and could be an insurance against depreciation.

If I today were to organize a company with a certain capitalization, and come to the Home Telephone Company, and say, "Gentlemen, I will make an appraisement of your property today, its value——" Or, take an older company, such as the Pacific Telephone and Telegraph Company, which has an older plant, that has been in use, and appraise it as it is valued today. "Now, I will insure that property against depreciation for a certain percentage"—I bearing in mind, of course, that what I will receive as a premium I would invest in some other securities which would yield an interest; that I would be earning money upon that premium all the time. I would agree for a term of fifty years to replace any worn-out part of any apparatus belonging to this company that had depreciated, the determination of depreciation as against mere maintenance or repairs being decided by the company itself as to what had depreciated. The company would pay me that premium. It would be a charge on their books of money actually paid out for insurance of the perpetuity of its plant, and would solve the question if the percentage which I claim for them could be deemed to be reasonable.

Those of us who have been in the business for a great many years have knowledge of what depreciation really means. I don't want to be egotistical nor tell you how old I am, but I have been in one business for thirty-five years. That would be time in which a plant that I began with, if it had faded away entirely and disappeared, would figure out a little less than 3⅓ per cent depreciation. I know from thirty-five years' experience in gas plants, and from more than twenty-eight years in electric lighting plants, what depreciation and obsolescence really mean from practical experience, and I know this: that a gas plant, in its entirety, with the exception, perhaps, of its gas mains laid under the streets, has a life not exceeding ten years on an average. Gas mains would have a life approximately of fifty years, possibly of seventy-five. I know of pipes in the ground today that have been in the ground for over fifty years, which, for the purposes of the business they are engaged in, are carrying the gas as well as they were fifty years ago. Steel structures as holders have a life of not to exceed thirty years, when they will have to be absolutely replaced. And so you can go down along the line of depreciation, and you can get men who have been in the business today long enough to determine just what the natural percentage of depreciation would be.

There is one thing over and above all else that has impressed me very much in corporate service; that is, that the corporations don't have their ears to the ground, in the first place, and they don't get next to the people, in the second. The characteristic of every corporation up to within a very few years has been to hold the public away, and not in any respect to take the public into their confidence. That spirit, entertained in the head offices of the company, goes down through the line of employees. Like master, like man.

But a few years ago the public-service corporations awoke to the fact that they were making a great mistake; that the public were getting stronger than they were, and they had to change their tactics to preserve their lives and reputations. Every corporation today in the United States that serves the public is doing all it can to cater to the public and to bring the public nearer to it, but they are not going far enough. The public only hear one side of a controversy, and that is through the daily papers. Conceding that the press talks to a biased public, the public-service corporation makes no effort, except in the way of advertisement, to reach the public. Advertisements are read, as all advertisements are, with certain grains of suspicion. I believe if the public-service corporation, through its trained engineers and employees, can get down from their pedestal to the level of the people, and walk with them hand in hand, in some way they can educate them, because the public want to know; they want to be taken into your confidence, and they want to believe you are right, and they will respect you because of your coming down and walking hand in hand with them.

That can be done in many ways, such as a more frequent appearance before the public of the officers and engineers of the corporation upon the technical side. The people are ignorant of what constitutes the phenomena, if I can call it that, that they are dealing with every day through the public-service corporations. They don't understand the mysteries of the automatic telephone service. They don't even know the Bell service, or what they do to carry sound such distances. They are perfectly dense as to how electric energy is produced and distributed. They haven't the remotest idea of how gas is manufactured, or what from, or what constitutes gas when it is manufactured. The schools don't go to the trouble to give them information on that point. The universities don't go to any particular trouble except in a general, technical way in electrical and mechanical engineering, and a little dab of gas engineering, leading up through the classes to graduation; so the student who graduates from the universities of this country, while he has a general theoretical knowledge of the elements of the sciences that enter into the business largely of public-service corporations today, has to begin all over again.

He is like a bookkeeper who has graduated from one of the business colleges, and goes into a mercantile house to keep a set of books. Before he can keep the books of the concern he has to learn its system. He has some of the fundamental principles, but none of the really practical ones. You cannot do otherwise in college. You cannot make specialists of men. You cannot put a man straight to a particular course and specialize him to one thing, and turn him out an absolutely practical, thoroughly trained electrical engineer. It would be too much to expect of the college to do that. There are too many other things for them to do; but what could be done is this: that if the men having the practical knowledge and experience from years of service in all of the things that the public-service corporations are engaged in doing, could spend a few of the dollars of the corporation in going before the children in the primary schools, the children in the grammar schools, and the boys in the technical schools, and the young men in the universities, and deliver weekly, if you please, lectures on the different topics, they would then be educating the young men as they

grew up in a proper way in that particular line with which, as citizens, they are going to have so much to do, and of which, as citizens, when they come out of the schools, they know so little. That is where the difficulty lies—the lack of education of the youth and people of today with regard to these matters. And I would go further than that. I would see that popular lectures were given here from to time, and they would become popular after a while—illustrated lectures, lantern-slide exhibitions, dealing with these complex studies. Bring in the people, the consumers, and educate them. Make an open book of your accounting to them. Prove to them positively that the statements you are making are correct, and gradually this feeling that exists against public-service corporations would fade away as the dew does before the morning sun.

It can be done, but it rests with you young engineers growing up the service of corporations, or in engineering work if ing up in the service of corporations, to so educate the people that the sciences to which you are devoting your life and that you spent your school-days in trying to acquire, would be used for the benefit of the people. Because if you can relieve the people of their bias and their prejudice, and get them to thinking for themselves, and thinking rightly and honestly, without bias or prejudice, you have accomplished as much as an engineer as you have in building any structure, no matter how grand it is.

I apologize for all this time, and I am very glad to have been able to say these few things to you. It is a subject that cannot be discussed in an hour, nor a day, nor a month, and if I can set any one of you young men here thinking, to go out and preach the gospel of fairnes to capital invested, which is for the benefit of the people, I won't have talked in vain; and I thank you, professor, for the opportunity you have afforded me by your paper to say this, and I thank you all for your patience in listening to me. (Applause.)

R. B. Daggett: The subject has been of great interest to me for several years. In a very small way I have attempted to do something along the lines suggested by Mr. Corey and Mr. Britton. It has always been my idea that the principal difficulty between the people and the corporation was that they did not understand each other. Of course, as Mr. Britton has said, some of the differences are due to what has taken place in the past, and abuses by corporations in the past have made it difficult for corporations to exist under right conditions now. Over in our town of Berkeley across the bay, we have a little club which meets occasionally, whose members are business men. Mr. Britton has said that the thing for the corporation men to do is to get next to the people. Now I am going to ask him sometime to come right over there and get next to us, and I am going to ask Professor Cory to do the same thing; and I think if we could get a few men who are known only in the newspapers as they appear sometimes in cartoons, and are not known at all as the men they are, to come before the people, why, a great many of these cobwebs would be brushed away.

C. W. Burkett: It was my good fortune to be in Wisconsin at the time the well-known Wisconsin commission was established. I was also at that time connected with one of the corporations that operated in the State and which was placed under the commission. I remember very distinctly the sort of dread with which the corporation looked upon such an investigation as a commission of this character would make—not so much because they did not have a good story, but they really had not thought about it long enough to know they had a good story. I believe it is the sense of the corporations operating in the State of Wisconsin today—at least the major part of them—that the commission there, which is composed of one engineer, one attorney, and one business man—has done a great deal towards establishing friendly relations between the public and public-service corporations in the State.

There is one thought in connection with Professor Cory's paper that I wish to mention, and that is that the average engineer, the engineer of today, as a rule has not given enough thought to accounting. Accounting, to the average engineer, is something that must be left to auditors. He must not know anything about it. That is one of the most serious mistakes that the engineer can make. The time has arrived that a man is not an engineer unless he is an accountant; and by accounting is meant the proper classification of all expenses in connection with any operation—a classification that will show costs.

The matter of the proper valuation on which to base rates is probably one of the greatest problems in rate-making today, and I will not attempt to discuss it, because I am not prepared to do so at this time. As to whether rates should be based upon first cost, which means the money actually put into the plant, or whether they should be based on what is known as the replacement cost—being the cost of reproducing the property as it exists today, or whether rates should be based on what is termed "going value", are all matters which have been and are being discussed by rate-making bodies today, such as State commissions and municipal commissions and investigating associations. There seems to be a sentiment at this time that the proper valuation upon which to base rates is the "going" valuation. The State of Washington has a railroad commission with a corps of engineers. This commission has done quite a good deal of work in connection with the railroads operating in Washington. Its method has been this: The engineers first established what they call cost. They made every effort to secure a figure which was the cost of the property. They next prepared for the commission another figure which they call replacement value, being what it would cost to replace the property today. After having prepared these two sets of valuations the engineers then gave the figures to the commission. The commission then arrived, for rate-making purposes, at what they were pleased to call a "going" value. This "going" value in the State of Washington, as I recollect it, was about 20 per cent higher than the replacement cost of the property.

I was quite interested in Mr. Britton's suggestion, that it might be possible to take care of depreciation through an insurance scheme, and it occurred to me that there might be some real merit in the suggestion, and that here might be an opportunity for a business undertaking of considerable importance.

A. H. Halloran: The "going value" mentioned by Mr. Burkett is now the subject of widespread discussion among those interested in the appraisement of public utility plants. It includes not only the physical value of the equipment, but also that intangible value which is attached to anything that is alive. No satisfactory definition has yet been given for this term which has been but recently coined. It will be but a short time, however, before the "going value" will be recognized as one of the most important factors effecting property valuation. Its most vital part is the element of "good will," that friendly feeling which Mr. Britton shows has been indifferently cast aside by some corporations. A company giving service to the public without the good will of that public is actually worth less in dollars and cents than is a company which has the hearty co-operation of its consumers. Just as good will is a corporation asset, so is its absence a corporation liability.

Mr. Britton has already shown how this good will can be created by educating the public about the company's work. Remove a little of the mystery that is attached to electricity and the secrecy that is associated with accounting and you will bring forth a popular sympathy whose value may be compounded annually.

The popular ignorance about the subject of reconstruction is surprising. It is not difficult to show that this reconstruction is necessary to take care of the wear and tear of daily use and is consequently as legitimate an expense as are the bills for lubricating oil. Many people have an idea that the charge for reconstruction is made to enhance the company's financial value much as reconstruction increases the worth of a ruby; moreover, that this increased valuation is as fictitious as is that of the artificial stone dug out of the crucible, which the jeweler is trying to sell as a genuine gem dug out of the ground. By citing a

maintenance expense with which everybody is familiar, such as the cost of mending a leaky roof, it is easy to make most people understand why this charge is made.

The matter of depreciation has been greatly systematized by engineers in the past few years. The telephone companies, in particular, have even plotted curves from which they deduce an annual depreciation charge, say 8 per cent. These charges, like those of cost data are not universally applicable. We cannot estimate depreciation value for the climatic conditions of California which would apply to the conditions in the East. Consequently every company in each locality is compelled to estimate its own depreciation account.

Now, a word of warning as to this scheme of governmental regulation which is being held as the panacea for all the evils of corporation misrule. Undoubtedly regulation in moderation is a good thing, but if carried to the extreme of governmental operation of public utilities, under our present form of government, we will be involved in difficulties of which we do not now even dream. In California we are suffering under too much municipal regulation. The tendency throughout the country is evidently toward State regulation and quite possibly national regulation of corporations. As long as these regulating commissions confine their efforts to the protection of the public and of the stockholders by deciding a proper rate for service, all will be well, but as soon as they attempt to dictate how the property should be operated they will meet with much the same troubles as do the labor unions when they try to say who shall and who shall not be employed. In other words, if corporation regulation be carried one step further to governmental operation then it borders on the socialistic, and is contrary to the principles of our American government, the principles upon which our past success has been based.

W. A. Hillebrand: I would like to ask if you mean that the good will of the consumers should be capitalized; and I would like to ask Mr. Burkett, in relation to the remarks he just made, if he knows why 20 per cent was added to the replacement value to make going value?

A. H. Halloran: The question of whether the good will of a corporation can be capitalized is a good deal the same as whether its franchise could be capitalized. The franchise is what the people give, very often for nothing, but within a few years that franchise acquires a definite value. If we were going before the Supervisors and say, "We are attempting to capitalize our good-will," we would be laughed at; but if we have a property for sale, and can show we have a certain stock in hand, and are supplying a certain demand, very good; furthermore, if we can show we have the good-will of the people we can get a better price than if everybody's hand is turned against us. At least it would be more salable and more likely to be acquired by a possible buyer.

C. W. Burkett: In reply to the second part of the question as to why the State of Washington added 20 per cent and called it "going" value, my understanding of that is this: There are many things done with a property that make it worth much more as a financial proposition than the amount actually expended on the same. Should earnings be based on the money put in the property, or on what the property is worth? Supposing you built a plant twelve years ago when copper was 12 cents a pound, and you tried to make rates two years ago when copper was 28 cents a pound, what valuation would you use for rate-making?

Question: Wouldn't that difference be taken into account in the replacement value—that is, the company is entitled to the increase in its value?

C. W. Burkett: I have read a great many discussions and talked with a great many people on this subject, and it is not clear to me, by any means, what is the right thing to do. What we are after is "the right." As I attempted to explain, the commissioners in Washington have arrived at the use of a "going" valuation upon which to base rates, for the reason that the property is worth that much; that is, what it would bring in the market today.

Question: What I am trying to get at is the reasons for the 20 per cent on what the replacement value is.

C. W. Burkett: A concern has, for example, contracts with other companies, which are valuable, which have not cost anything, perhaps, and those contracts have a very real commercial value. As to whether that should be capitalized or not, whether rates should be based on that valuation, is the problem; but that is the way I understood the Washington commissioners decided was equitable.

John A. Britton: The question of the value of the plant, based upon its being a going concern has been covered by a number of decisions in the Supreme Court of the United States, where that question has been discussed and argued. I think it is a good deal like good-will, in a way. Of course, no one for a moment (to take a concrete example) would suppose that the "White House" would sell you its business tomorrow based upon the value of the stock it carries on its shelves. It has a good-will as a going concern, having an established reputation, location, and so forth. And that goes into the question in the courts, as to what constitutes a going concern value, much upon the lines that Mr. Burkett has suggested, of contracts in existence. But in railroads, more particularly, they have argued that it applies as well to the pioneering efforts of the company in opening up territory, in building for itself a business that before was not there and from which no revenue was obtained, and succeeding by opening this territory in making that a tributary, profitable business, that that should enter into the valuation besides rights of way and rolling stock. In other words, it has built up a going business that has created trade, and that has a capitalized value. In fact, the Supreme Court of the United States, in the Consolidated Gas case, went as far as to say that by reason of the possession by the gas company in New York of a monopoly, due to the fact that the municipality would never countenance the tearing up of its streets for the general laying down of conduits for conveying gas, it was entitled to have considered, in the appraisement of its value, this value of a monopoly; it suggested as a possibility that might be considered. It did not rule on that point. But the Supreme Court has in many cases decided that the operation of any public service, in developing territory and producing a revenue, by that means constitute a certain capital over and above the intrinsic value.

While on my feet I want to say this, that in California we have been confronted with the decisions of the State courts that only permit corporations to take into consideration the matter of valuation in fixing rates, the absolute value of the property actually in use. If considerable of the property of the company has been bought to stifle competition, to shut out possible reservoir sites, or obtain valuable rights of way, that would not be considered if not actually used, nor would vacant property, bought years ago for possible use and never used, by reason of the business, or absorption of competitors, or otherwise, that they could not obtain a revenue on that, and that would not be allowed by the courts; but other than that they do allow and will allow, I think, in all future times, a value over and above the question of intrinsic values as a going concern for the business developed.

H. T. Cory: I am not a member of the American Institute, but I am a member of the American Society of Mechanical and Civil Engineers, and I have been very much interested in this talk this evening. I was no little surprised to hear Mr. Britton say he would be very willing to enlighten the public as to public corporation affairs. I have been until very recently general manager of two corporations, one on the American side of the line and one on the Mexican side. On the Mexican side of the line, as manager of that corporation, I have had to deal with the offcials in the City of Mexico, who were specially trained in their work. So far as rate-fixing on the American

side was concerned, it was a question of dealing with the board of supervisors of a county, a very small and new county.

The amount of regulation in Mexico is something phenomenal as compared with this country. In America we can build our canals where we please, and put up the sort of structures we please, and do pretty well as we please. In Mexico we dare not put up a structure or dig a canal without the special approval of the Mexican officials. I was very frank in talking to the Mexican officials, giving details of the cost of every structure. The reason I was willing to do that was because I knew that in Mexico I was dealing with a man who knew what he was talking about. I was afraid to give out any information on the American side of the line because the newspapers and the various people who had axes to grind would distort that information and keep me forever explaining, and nothing is so annoying as to explain and explain and explain, over and over, to people who are trying to twist the words you utter into different meanings.

I have heard a number of corporation men say they would rather do business the corporation way in Mexico than in America, and yet in Mexico rates are absolutely fixed for railroads. All railroads at the end of ninety-nine years become the property of the State, without the payment of a cent of money. Time-cards must be approved before they can be put into effect. Books are gone over by government experts, and statements taken from them, and there is a degree of regulation that would make the railroad men in this country wild. But it is accepted in good part, because you are not dealing with the dear people, but with experts, and that is a great difference.

I do not believe that the corporation people in this country are dishonest or are not frank with the people, excepting for the reason that they dare not be frank. They are dealing with people who are not acquainted with the subject, and in Mexico you are dealing with people who are.

Incidentally, with reference to that "going business," the Assistant Secretary of State of Mexico gave me a very good illustration of what he understood by going value. He said: "There have been a number of irrigation enterprises started in Mexico. Many of them have failed. We do not regulate their rates. It is not necessary. Some have succeeded. Those who have succeeded are entitled to a percentage on the risk which they have encountered by going into the business at all." In short he allowed 2 per cent, which is just about equivalent to your 20 per cent of the Wisconsin commission for going business, to allow for the fact that in entering that business at all the man has risked his money by making a failure.

Finally, there is another phase of it. Suppose I go into the dry-goods business today. I may fail. I may make 20 per cent. If I make 20 per cent, there is nobody going to regulate me or to reduce that amount. In other words, there is no limit to the maximum I can make on the business investment in a private corporation, and there is no limit to the minimum. In a public-service corporation, however, the people do not guarantee to the public-service corporation a minimum return on its investment—do not even guarantee that it will come out even. It merely says you cannot make more than a certain amount, and that amount is not very big. It seems to me, therefore, that the "going business" of a public-service corporation is a matter which should be considered as representing that one factor, namely, that while, on the one hand, the public reserves the right to regulate rates to keep the earning capacity down to a reasonable amount, it does not, on the other hand, guarantee anything. In a private business you have no such limits, and you have the same amount of guarantee against failure, namely, none at all.

R. B. Daggett: The subject Mr. Cory has mentioned brings up this point, that the public utility corporation has more or less of a monopoly. Supposing a private individual wants telephone service put in, and he calls up the telephone company, and he gets it put in in a reasonable length of time, that time, he has no redress. Now a private individual, engaged, say, in selling shoes, if he is called up on the telephone and he is told, "I want a certain number of pairs of shoes sent to my place," and they are not sent over in the course of an hour, the man says, "I don't want to do business here, I will do business with somebody else." So the man who goes into private business is entitled to more, if he can make it, because he has no monopoly; but the public utility corporation has that monopoly; it has that hold on the people.

Another point that Mr. Burkett brought up was insurance against depreciation. The corporation that I have been identified with for over thirteen years has been into that subject in many different ways. When it first went into business it was necessary to insure in order to do business at all, and the company tried to charge a sufficient price so that if it did not guess right on the depreciation it still would come out all right. Later, as the business got on its feet, it was found unnecessary to make this insurance in order to do business, and as the apparatus was not operated under the best conditions when its was insured, that insurance business was discontinued. Now the experience of engineers has made it possible, with the data that we have, to make insurance propositions on a very close basis and come out very nearly right; and I presume, with any kind of engineering apparatus it would be possible to do that.

W. H. Seaver: As to the cost of operation, I am not familiar with it from the corporation standpoint, except as to manufacturing—not in regard to the distribution of power, manufacturing of power or anything of that kind. It would seem as though it would be comparatively simple to determine the actual value of a plant—perhaps not comparatively simple, but nevertheless not impossible, to determine the depreciation; but the question of cost of operation, while it can be determined for the past, is one of very great difficulty in trying to determine it for the future. I have known many instances in the cost of manufacturing where the fluctuations have been through such tremendous differences that the variations in selling price could not keep up with them. At times, as business would fall off, the cost would increase to such an extent that even with high prices for the selling value the business would show a loss. At other times, in reducing the price of the product, the costs would be so greatly reduced by increased sales that the profits would be increased tremendously. I know a certain manufacturing concern in Connecticut. They had a certain department that made cheap goods, but hadn't made any money. Finally the proprietor took it into careful consideration. He decided that he would take everything that came for a year, and see what the outcome was. On every order that he took he had a system of estimating costs from time to time. Almost every order that he took showed a loss compared with the figures given by the cost department. At the end of the year he had a record made of the actual expense of the department, and found he had made a handsome profit. Those factors must enter into the cost of the production of power as well as other products; and, possibly with the exception of the telephone business, the greater the business the lower the cost. That is a question that enters into the fixing of rates for the future, and as I look at it, it must be an uncertain quantity, and I should think, from the standpoint of the public-service corporations, it would be a very difficult one to determine.

George C. Holberton: There is one point that Professor Cory brought out that I think is worthy of consideration and to which we should all give some thought, and that is the term "piece-meal construction." I think that is an argument against allowing a rate based solely on the replacement value, because a plant is not replaced, neither is it built in a day, a month, or a year. If you take and set out to build a pole line, you will arrive at a figure very much less than the actual cost, or the cost representing the money actually paid out, due to the fact that pole lines are not built in the way

is very well; but if he has to wait a month, or even some shorter that you would probably estimate them. The town grows gradually. A pole is added here and another pole somewhere else, and it cannot be done on the basis of a figure that an engineer might give in building the whole under one contract. In other words, he could build a mile of pole line a great deal cheaper than it has cost the company to build that particular mile of pole line, because it did not build it that way, but built a few hundred feet at a time.

M. M. Libby: May I add a word about replacement values, it having been my good fortune in the engineering business to have been concerned with some of these things that had to be insured, and to have to operate and take care of insured apparatus, apparatus whose life was guaranteed a certain time. In that time I have seen changes take place in apparatus that was insured for ten or fifteen years, so that the appartus was dumped on the scrap and replaced by other apparatus.

These new terms, such as "going value", have not been sufficiently defined as yet. The whole thing is moving along so fast that we have not language to express our ideas; so when one gentleman speaks of replacement value, and another one of some other feature of this business, we are not always thinking the same thought.

The 20 per cent spoken of in the case of Washington makes me think of a matter that came to my attention recently. I had occasion to wait patiently for an interview, and during the process I overheard the explanations which were made when certain replacements and repairs exceeded the values estimated by the engineers in charge; in other words, matters of small import compared with the valuation of the railroad; but the work had been ordered upon the probable expenditure of a certain sum of money to accomplish a certain result. Invariably the expense exceeded the estimate by 33⅓, 50, 40, and in some cases over 50, per cent, which goes to show that the engineer as yet has not gotten suffcient training to really determine the replacement value. I have had occasion to look over the estimates made by engineers of great repute in which the item of 10 to 20 per cent had to be put in their estimate for items that they could not really determine beforehand, because they knew from work that has already been done, and after men had carefully made estimates, that they could not predict the cost close enough to warrant capitalists in taking hold of it.

I want to bring out the point now, that particular point, that I fear that the term "business man" has been made to include too many of the "common people," and has been given a little bit of a black eye as compared with the engineer. I think we engineers have a great deal before us in the way of estimating, before telling these things for the benefit of those who employ us. The man who made the estimates which overran 33⅓ would not be a very good employee for a contracting concern. It is a vast difference, being employed for a person who is going to have the work done, anyway, and wants your ideas as to what it is going to cost, and being employed by a concern where your estimate determines whether they are going to do business tomorrow and the next day, and have a little profit for their own use. I think if we get in line with the work that is before us, we will be able to call in the business man and explain it to him. My experience has been that the business men who are about to invest money—and those are the men I have classed as business men—men who are dealing in financial matters—as a rule have the engineers up a stump, and there are only a few of the commercial engineers who are really able to do business with the financial men, because the financial men have the best of it most of the time.

Our paper tonight was so brief that almost any of us can get up and take more time in the meeting than the paper itself; but it takes a great deal of thought and effort to find language sufficiently plain and elementary so that it can be applied to the subject and not lead us off into the mystery and maze where we won't accomplish anything. I think the example given to us by Professor Cory warrants further study, and I think it would be better for each of us to give some thought to how the questions raised tonight can be answered in the simple language of the example given in the paper.

C. L. Cory: I will add just one or two words. I want to recur to one point that I made regarding the almost universal necessity of the public-service corporation finding it necessary to dig up probably a lot more money than it earns, because we discussed the matter of trying to educate other people only as applied to the proper return on the investment. Suppose any one of us has the sum of $5,000, and we loan it on a mortgage and get 7 per cent. That is $350. Now let us suppose, in order to hold that loan, we had to dig up every year $700. Is the 7 per cent rate sufficient? Many of you know much better than I how absolutely necessary it is to meet the enormous expense of these extensions. It is a point that has not been discussed generally, but is worthy of serious consideration.

The discussion this evening has, I think, justified the very brief paper. I told you the story about the college graduate and John Hay. I don't need to say any more. I do want to add this, however. The study of these matters is not like the study of Ohms's law, nor can you solve them with the slide-rule. As we found this evening, the very terms we were trying to use, we do not know the exact definition of them. How can we get it? I think the best thing we can do is to get down and study it, everyone of us, perhaps, with one exception, because they are so new. I don't know of any better place to study it than to follow—as has been indicated to us this evening by Mr. Britton—the work of the Massachusetts commission and the Wisconsin commission. Their publications are available *in toto*. I don't suppose those commissions—in fact, I know some members of the Massachusetts Highway Commission themselves did not know the proper definition of those terms we have been discussing. Let us get together and take that up, and perhaps let Ohms's law alone for a little while, and I think we will be a good deal better engineers and better members of society, and of very much better service to those who have the right to look to us for loyal service. We will be a good deal better bunch of engineers than if we stick to those other things exclusively.

JOINT ELECTRICAL BANQUET IN LOS ANGELES.

A joint banquet of the Los Angeles Section of the American Institute of Electrical Engineers and the Rejuvenated Sons of Jove was held at the Hollenbeck Hotel in Los Angeles on March 12, 1910.

F. B. Crocker, professor of electrical engineering at Columbia University College, New York, and past president of the A. I. E. E., gave the members an interesting address on conditions in electrical matters in foreign countries, having just returned from his second trip around the world, the first trip being eleven years ago. Dr. Crocker especially spoke on India, China, Japan, and having visited these same countries on his first trip had an opportunity of studying the growth of this work, which in India and China was very discouraging to the American engineers, on account of their extreme conservatism, a point in which they take considerable pride. The lighting and street railway work is slowly going forward but the telephone was not much used as the natives do not seem to care for this particular branch of the science, especially the long-distance work. In Japan, however, all branches of the electrical industry are booming and they are rapidly developing their hydro-electric plants, mainly on account of the many opportunities offered for development along this line. Dr. Crocker also made a few remarks concerning the inception of the A. I. E. E., having personally been president when the organization was founded. The members thoroughly enjoyed Dr. Crocker's address, and appreciated the opportunity of having him present.

J. A. Lighthipe addressed the meeting on the early days in Thomas A. Edison's laboratory. Mr. Lighthipe went to Menlo Park and became associated with Mr. Edison in 1879 and his remarks were among the most interesting of the

evening. Mr. Lighthipe spoke principally of the early work done on telephone apparatus and Mr. Edison's endeavors to get a loud speaking instrument, but this work was soon given over to the electric light end of the industry, which at that time was just beginning to interest the public. The early work done on incandescent lamps as well as generators and their experience given by one who was on the "spot" at the time to see the development, is a subject of never tiring interest to any one in the electrical fraternity and can only be appreciated by hearing it told in Mr. Lighthipe's inimitable manner. While he exceeded his time limit for speaking, every one present would have gladly stayed all night if he would have been willing to have continued.

E. F. Scattergood, chief electrical engineer of the Los Angeles Aqueduct, chose as his subject "Engineering," a subject that could not possibly have been delivered in a more thorough and satisfactory manner than was given by this gentleman. He spoke of the enormous good that can be obtained by co-operation among engineers and by every member of the profession having his data files open to his brother engineer, likening the profession to medical work where nearly every doctor of standing in the world gladly contributed his findings on a particular subject to the good of the profession in general. Mr. Scattergood stated further that the student of electricity must devote his life to the science and its application more than to the financial remuneration he personally might gain. That Mr. Scattergood's speech was appreciated was demonstrated by the remarks heard after the meeting adjourned and his ideas of co-operation sank into the heart of every man present.

One of the most interesting talks of the evening was that given by O. H. Ensign of the U. S. Reclamation Service. Mr. Ensign took up the work at the very beginning, outlining its scopes, resources and development, treating each subject in a manner so interesting that the writer could not waste a word in an endeavor to take notes, selfish but justified. One cannot appreciate the magnitude of the enormous undertakings of this department by simply reading a report of each project, but must hear it given by so able and easy a talker as is Mr. Ensign. The members can congratulate themselves on the opportunity of hearing Mr. Ensign on this subject, as such opportunities are rare..

In the absence of H. C. Bowers, H. B. Woodill took up the subject of "Contracting" and ably represented that branch of the industry. Mr. Woodill confined his remarks to the early days of the business, being one of the oldest contractors in Los Angeles, describing the methods of installation in those days as compared with the present-day construction. The subject was handled in a competent manner and Mr. Woodill took this occasion to say that the contracting and engineering work should be separate and distinct, inasmuch as very few contractors were capable of doing engineering work, but rather than lose a contract most of them would attempt work that naturally reflected discredit on the engineer's profession when the result of such an attempt proved unsatisfactory.

E. R. Northmore presented a paper on the lighting companies, covering the electrical work in Los Angeles from the beginning to the present day, also the benefits to be gained by joint pole construction. The paper is printed elsewhere in this nnmber, and is interesting to those familiar with the rapid development of electrical matters in this territory. Mr. Northmore began work on the first plant in Los Angeles and, staying with the same company to the present day, certainly can be conceded authority on the subject presented and the early day work, when he read all the meters, "shot" all trouble and generally took care of all outside work in the city, makes interesting and amusing history, of which Mr. Northmore can well be proud.

C. W. Koiner presented a most interesting paper on the aims of the A. I. E. E. and the growth of the local section. This paper is also printed elsewhere in this number and is well worth reading, not only by Institute members but by non-members, as it carefully details the work laid out by the directors of the Institute, and the standing of its members and associates. The figures given by Mr. Koiner were carefully obtained and are as accurate as can be compiled and the members are deeply indebted to Mr. Koiner for the time he put in, in getting this before them.

A. W. Ballard closed the meeting with a short address on the Rejuvenated Sons of Jove, who they are and what part they take in the electrical field. Their chief object is to boost everything electrical, consequently is a worthy cause and a subject for serious consideration by every one in any branch of the business. The local organization started about 18 months ago with four members and has a present membership of about 40. Mr. Ballard stated further the Sons of Jove were really the social end of the A. I. E. E. and hoped to see all of the members soon "ride the goat" in the Sons of Jove and would personally see that they got their money's worth.

NEW CATALOGUES.

"Northern" Type B direct current motors are interestingly described in Bulletin 1119 from the Fort Wayne Electric Works.

The Cutler-Hammer Manufacturing Company are distributing a folder showing their lifting magnets in construction and in use.

Bulletin 1118 from the Fort Wayne Electric Works illustrates and describes the construction, design and operation of their Type A constant potential transformer.

Barrett jacks are illustrated and described in catalogue No. 109B from Fairbanks, Morse & Co. This includes all forms of lifting jacks specially adapted for railway work.

Ad Book No. 13 from the Westinghouse Bureau of Publicity contains examples of a number of excellent newspaper advertisements for central stations. This number is devoted to "moving day."

The Duplex Metals Company of New York has issned in pamphlet form an attractive advertisement on standard specifications for hard-drawn, copper-clad steel wire and copper-clad steel bond wires.

The February number of "Hot Points" from the Pacific Electric Heating Company of Ontario, Cal., is known as the catalogue issue and contains illustrated descriptions of the various heating devices manufactured by the company.

Fairbanks, Morse & Co. of Chicago, Ill., have just issued their new Catalogue No. 113, which fully describes and illustrates their 1910 line of two-cycle marine engines. The four-cycle heavy duty Fairbanks-Morse marine engines are fully described and illustrated in Catalogue No. 112B, which is very attractive and which contains complete information covering this line.

The General Electric Company has just issned a pamphlet, No. 3894, on the subject of Building Lighting, which should be not only of interest but of service to managers of hotels, apartment houses, and all large buildings of either a public or private nature. This pamphlet contains references to a number of important installations of lamps having tantalum and tungsten filaments.

The Harvard Electric Company of Chicago and New York City have issued a new catalogue known as No. 20, which is descriptive of a part of the many electrical necessities made by the Harvard Company. In this bulletin, which relates chiefly to Harvard patent galvanized channel steel brackets, sectional switch boxes, conduit boxes, fuse wire, fuse strip, open fuse links, Harvard bevel edge self-welding wire joints, fuse blocks and telephone fuses, test connectors, cable hangers, etc., etc., there is given a detailed description of the various Harvard specialties, dimensions, etc.

THE LIGHTING COMPANIES OF LOS ANGELES.[1]

BY E. R. NORTHMORE.[1]

Los Angeles, in the electric business, as in everything else, is always among the first. One of the first plants for furnishing street lighting was installed in this city about twenty-seven years ago. At this time Los Angeles was a small town of 13,000 inhabitants and the lighting was distributed by six masts, 150 feet high, at the following locations: S. P. River Station; Commercial and Main; First and Central; Sixth and Main; First and Boyle, and Avenue 24 and Downey. These masts were first installed in conjunction with enough arcs at street corners and in stores to make a load of 50 arcs, or enough for one Brush arc machine.

As the town grew to be a city, commercial lights were gradually installed in the business district, so that in 1893, or 10 years after the plant was installed, the entire output of the only electric plant had grown to the enormous load of 250 street arcs (moonlight schedule), 250 commercial arcs and 2000 16-c.p. flat rate incandescent lamps, all commercial lights being turned out at midnight. You want to remember that in these early days, the city did not grow as fast as it does now.

In the year 1896 another lighting company commenced operation in this city with a small steam plant of about 500 kw. capacity, at Second and Beaudry streets, working in conjunction with a water power plant and high tension line from Santa Ana Canon.

In 1898 another plant commenced operation at Third and Los Angeles streets, with a capacity of 300 kw., and they also brought in about 400 kw. high tension current from the San Gabriel River. Again Los Angeles was the pioneer, as these were the first successful high tension lines in the world.

In 1897 the city created the first conduit district, ordering all the poles and wires from the streets and alleys in the district bounded by Seventh, Los Angeles, Massachusetts, New High, Temple and Hill streets. One of the lighting companies installed the original Edison tubes, one used paper fibre conduit incased in concrete, and the other used redwood planks with grooves cut in them. The only conduit which has held up to date is the paper fibre conduit incased in concrete.

At this time the center of the load was at First and Spring, and all the companies ran very light cables south of Fourth street, as they all decided that there was not enough business to warrant pulling in heavy cables.

One of the most important changes introduced recently and one that has been promoted primarily in the interests of the lighting companies, is the Joint Pole proposition. This was originally planned by the lighting and railway companies in Los Angeles, but the scheme has spread so as to include many of the telephone companies in Southern California, and in three years of operation it has developed into one of the most important lines of activity.

In this city alone, over 15,000 poles have been eliminated in three years, and five years more is going to see practically all overhead construction work in this city on common pole lines. Construction is done under rigid specifications, making it safer, better and cheaper, and, in addition to this, the public have been satisfied. Formerly it was often a very delicate matter to undertake setting a pole in a location where three or four "sticks" already walled in the perspective. We have had cases where angry property owners have camped in a half-dug hole, for the purpose of obstructing and preventing the completion of the work, and yet we were acting only within our franchise rights in furnishing the particular service demanded of our companies.

I mention this work simply to show what may be done by co-operation. Competition may be as keen as ever with us, but when it comes to satisfying a public demand and getting the most for the least expenditure of time and worry, the use of joint poles is to be considered an important factor.

The committee furnished records of all combinations, and that in itself is an important item, introducing a standard method of mapping the pole plant of the various companies. I have on file in my office over 2000 blueprints, each indexed carefully according to street locations and cross indexed with cards according to owners, and all we have had to do with these is to file them as furnished month by month—and incidentally pay our proportion of the expense of the committee.

The Joint Pole Committee is composed of a representative from each of the lighting, railway and telephone companies, who in the beginning appointed as secretary, Mr. J. E. MacDonald, who is handling this work in a very competent manner.

The companies are heartily in favor of the American Institute of Electrical Engineers and Sons of Jove and are its best boosters. There are 67 members, or 60 per cent. of the total membership of the local section of this institute who have been or are at present employed by the companies, and by looking over the list of members we find men of world-wide reputation, who stand among the highest in the electrical fraternity, and the majority of these have at some time been connected with and received some of their best training from the companies, and I feel sure that there is just as good "timber" in the younger element, and I believe that the lighting companies are giving them a show and boosting them wherever possible.

[1]Paper read at joint banquet A. I. E. E. and Sons of Jove, Los Angeles, Cal., March 12, 1910.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.[1]

BY C. W. KOINER.

The American Institute of Electrical Engineers is the national society of the electrical profession, and was founded 26 years ago at just about the beginning of the electrical industry. Its growth has kept pace with that of the electrical industry which is without a parallel. To measure the growth and the importance of the Institute it is necessary to consider the tremendous growth of the electrical industry.

The first telephone exchange was not installed until 1878 and there are at the present time 5,500,000 telephones in use in the United States alone. The first central station was installed in 1882, and at this time

[1]Paper read at joint banquet A. I. E. E. and Sons of Jove, Los Angeles, Cal., March 12, 1910.

there are 6,000 stations, not including the many more numerous isolated plants. These central stations have an income of $250,000,000 a year, and develop 2,250,000 h. p.

The first electric railway in this country was installed in 1888, and there are now in operation 90,000 cars on 40,000 miles of track, with earnings of $475,000,000 per annum.

It is estimated that the investment in the various electrical industries is $6,000,000,000, and this industry has been developed within the last 30 years. It represents approximately half the value of all our American farms.

The electrical industry has grown to a point where the amount of business transacted per annum amounts to one and one-half billions of dollars. The estimates and statistics compiled by the "Electrical World" for the year 1909 shows that the value of manufactures, machinery, etc., amounts to two and three-quarter millions of dollars. The earnings of electric railways amount to $475,000,000; of central telephone stations $250,000,000; of telegraph stations $60,000,000; of isolated plants $75,000,000; and miscellaneons $50,000,000.

The institute has played a very important part in this stupendous development and its membership is directing all of the great variety of electrical industries. From the few members at the time of organization the institute has grown until it now has 6,000 associates and 500 members and is the largest of the engineering societies. All branches of engineering are represented in the membership and its members are scattered all over the world. While this is our national society, its members are called to all parts of the globe, in the capacity of constructing, operating, and managing engineers.

The importance of becoming a member of the institute should be impresed upon all electrical engineers. It enables them to keep abreast with modern engineering practices through the institute papers and discussions. The papers represent the very best information that is to be had and are written and discussed by the very brightest men in the profession.

All young engineers should become identified with the society which has helped to make electrical engineering what it is and which has made the path easier for the younger engineers, and for those who are interested in the advancement of the electrical science.

We are deeply indebted to the men who founded this society, to those who foresaw the advantages of an organization of this character. The engineer owes it to himself as well as to the institute to become affiliated with the recognized electrical engineering society of his country. He can be inspired by no better object than that of the institute which bears repeating here.

"Its object shall be the advancement of the theory and practice of electrical engineering, and of the allied arts and sciences, and the maintenance of a high professional standard among its members."

Special emphasis must be put upon the objects quoted here. An engineer whose code of ethics is not in keeping with the high standard of the institute has no place in this society.

The institute will continue to grow in numbers and importance. The application of electricity for power purposes in all lines of industry necessarily requires a large number of engineers. Hence the institute is destined to become a very large engineering body. Because the society will necessarily be large in numbers does not mean that the standard or quality of its membership will be lowered in the least.

The government of the institute is vested in a president, six vice-presidents, twelve managers, a secretary, and a treasurer. These officers are supplemented by a necessarily large number of committees numbering 19 or 20.

As you are aware the institute owns an interest in the Engineering Building, which is a partial gift of Mr. Andrew Carnegie. Last summer while in New York I had the pleasure of being shown through the building for the first time. This building is a model of its kind, having been primarily designed for the three engineering societies that occupy it. It is located on West Thirty-ninth street and is easily reached by car lines radiating to all parts of the city.

The library is located on the two upper floors. It is composed of the scientific works of the three societies which occupy the building. It is of course one of the greatest and most useful parts of this engineering home. Our institute alone has 18,828 volumes in its library.

It may be interesting to note that the assets of the institute is about $670,000.

One of the many good things which the institute has accomplished was the introduction of standardization rules. A committee was appointed and continued until these rules were evolved and adopted. And they are such that we could hardly dispense with them.

The institute is necessarily represented in the various large centers of business by sections and branches. These sections and branches enable the members to meet together for discussion of the papers presented in New York, or for papers that may be written by its local members. There are now in existence 25 sections and 27 branches.

It is fresh in your minds how 19 or 20 months ago we of Los Angeles came together and decided that we would organize a section. Much enthusiasm was manifested at the time and I am happy to say that it has not abated. We began with about 25 members, and today I believe we have 100 additional members. Los Angeles section, though one of the youngest, is ninth in point of members. You are to be congratulated on your diligence in building up your membership.

Los Angeles section exceeds all other sections in growth for the last year. We are the largest west of Chicago with one exception, San Francisco only exceeding us. The chairman of our membership committee is now planning to do some very effective work towards increasing the membership. And this is to be done without lowering the standard or the quality of our membership. I sincerely trust and believe that our section will continue to have a healthy growth and will grow in influence and usefulness to its members.

We must not forget we will be able to extract only in proportion to our in-put; that is to say, only as we work for our section will we be able to enjoy its benefits to their fullest extent.

THE WATT-HOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER III.

(Continued.)

Polyphase Meters.

The polyphase induction watt-hour meter for use on either a two or three phase system consists essentially of two single phase meter elements mounted one above the other on the same shaft, and having but one register. The principle of operation is identically the same as that previously explained for two single phase meters, except that in the case of the two single phase meters, the algebraic sum of the two registers is taken to obtain the total power, while in the case of the polyphase meter this is automatically accomplished by having the two discs connected to one shaft. The polyphase meter has the advantage of being easy to read and install.

The polyphase meter for use on three phase four wire systems when used without current transformers is of somewhat different construction from the meter used on three phase three wire, or on two phase systems. In the three phase four wire meter without current transformers, it is necessary to have a current winding in the meter for each phase. These windings are arranged on the two elements in such a manner that the current in one phase passes through a winding on each element; the current in each of the other two phases passing through a winding on one

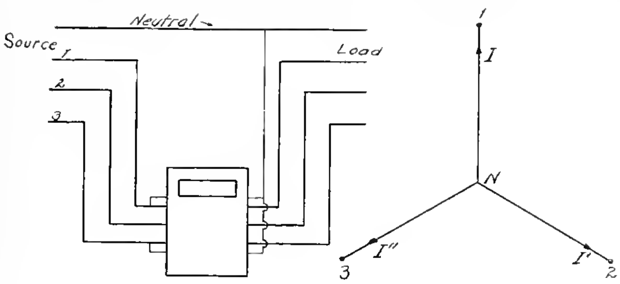


Fig. 40.

element. Fig. 40 shows the vector diagram and also the diagram of connections of this type of meter, in which I, I' and I'' represent the currents in phases 1, 2 and 3 respectively, and 1-n, 2-n and 3-n represent the voltages between the legs 1, 2 and 3 and the neutral wire, n. One element of the meter has the voltage 3-n impressed upon its potential winding, and the current I'' passing through one set of current coils, and the current I' passing through the other set of current coils. The other element has the voltage 1-n impressed upon its potential winding, and the current, I passing through one set of current coils, and the current I' passing through the other set.

A three phase four wire system is, in effect, three single phase systems, the current in each system being the current in the corresponding phase, and the voltage of each system being the voltage between the corresponding phase and the neutral.

With the connections described above, the power being transmitted by each of the two single phase systems, 3-n and 1-n will be correctly recorded by the meter for both unity power factor and for power factors other than unity, as each element of the meter will act as a single phase meter in recording this power. The power being transmitted by single phase, 2-n will be recorded partly by one meter element and partly by the other. The current I' passes through both meter elements, the connections to its coils being reversed so that for unity power factor it is 60° out of phase with the voltage impressed on each element. (If these coils are not reversed the current, I' will pass through the meter 120° out of phase with the voltages impressed on the two elements and will subtract instead of adding the power in phase 2-n.)

Since the cosine of $60° = 1/2$, one-half of the power will be recorded by each element. For power factors other than unity, one element will record more than half, and the other element will record less than half the power being transmitted; the sum of the power recorded by both elements will be equal to the total power.

When current transformers are used with three phase four wire meters, the standard polyphase meter as used on three phase three wire circuits may be used, the current transformers being so connected that the resultant current of phases 3 and 2 passes through the current coils of one element, the voltage, 3-n being impressed on this element; the resultant current of phases 1 and 2 passes through the current coil of the other element which has the voltage 1-n impressed upon it.

The action of this type of meter is the same as just described for the meter without current transformers. In the latter case, two sets of current coils are used on each meter element, the resultant effect of the currents in these two sets of coils being the same as the resultant of the currents from two current transformers passing through one set of current coils.

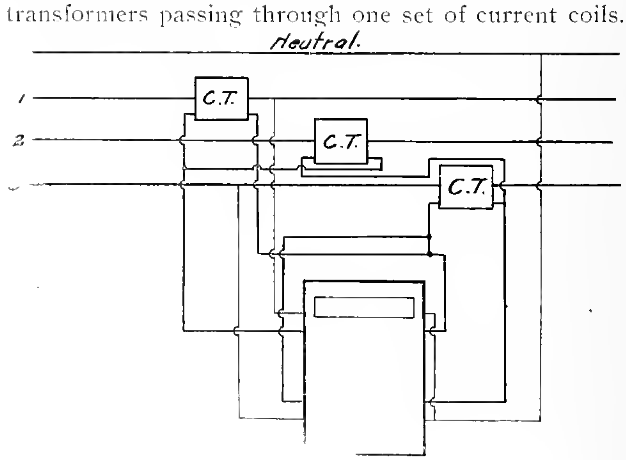


Fig. 41.

Fig. 41 shows the proper connections for a polyphase meter when used on a three phase four wire system in conjunction with current transformers.

Adjustment of Elements.

Polyphase meters should be provided with some means of adjusting the torque of one of the elements without disturbing the other. This is necessary because there is only one retarding system which is common to both elements, and it is therefore necessary that some means be provided so that the two electrical elements may be adjusted to give the same torque when the same amount of power is passing through each. This adjustment is readily accomplished by changing the number of turns on the potential winding of one of the elements. By this means, the torque of that particular element can be adjusted to be the

same as that of the other element. This is done in some meters by bringing out a number of taps from the potential winding, having a very few number of turns between taps, so that a fine adjustment can be accomplished.

Other meters employ what is known as a "balance loop," which is a short-circuited turn whose position can be so changed that it will introduce more or less reluctance in the path of that portion of the flux from the potential winding which does not pass through the meter disc. Increasing this reluctance will cause more of the flux to pass through the meter disc, while decreasing it will cause less flux to pass through the disc. After adjusting the "balance loop" the meter should be "re-lagged."

The balance between the elements of a polyphase meter can also be altered by changing the air gap between the potential and the current coil poles of one element; this can be accomplished by loosening the screws and prying the poles further apart or by using a light wooden mallet to drive them closer together. The adjustment obtained by this means is necessarily very rough, but it is sometimes useful (usually when putting a new potential coil in place) to bring the elements within the range of adjustment provided by the manufacturer.

Interference of Elements.

Polyphase meters are subject to one source of error from which two single phase meters used on polyphase circuits are entirely free, that being the "interference of elements," which is due to the interference or reaction of the magnetic fields of one element with the fields of the other, and in some cases it introduces errors amounting to as much as 4% or 5%. For this reason the elements should not be placed too close together. In a well designed meter operating near unity power factor, the error from this source should never amount to more than 0.5%.

Polyphase Meters on Six Phase Circuits.

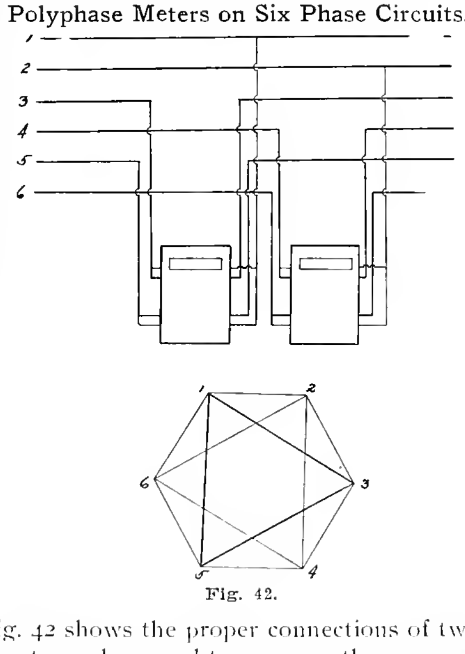


Fig. 42.

Fig. 42 shows the proper connections of two polyphase meters when used to measure the power flowing in a six phase system.

Metering High Potential Circuits.

When meters are used on high potential circuits, the secondaries of both the potential and the current transformers should be solidly grounded. This is not only a precaution for the safety of those who have to read and test the meter, but it also prevents undue strain between the windings of the meter. Both the potential and the current transformers act as condensers, and so do the windings of the meter themselves. The voltage of the system is thus impressed across several condensers in series, the strain across each condenser being inversely proportional to its electro-static capacity. It is possible for the strain thus impressed to reach a value which will puncture the insulation from the winding to the core.

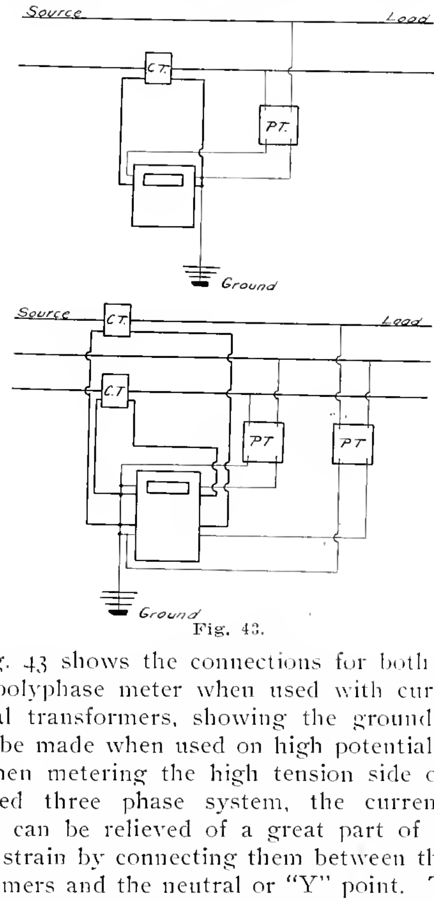


Fig. 43.

Fig. 43 shows the connections for both a single and a polyphase meter when used with current and potential transformers, showing the ground connection to be made when used on high potential circuits.

When metering the high tension side of a "Y" connected three phase system, the current transformers can be relieved of a great part of the high tension strain by connecting them between the power transformers and the neutral or "Y" point. This will also protect the current transformers from lightning and high potential surges, as each current transformer will have a power transformer between itself and the line.

Current and potential transformers used with watt-hour meters should never be operated under the condition of overloads, and it is best to have them operate considerably underloaded. Overloading the transformers will cause the meters to run slow.

Current transformers are usually rated at so many watts, for instance, 40 watts. The sum of the volt-amperes taken by all the meter coils in series with such a transformer plus the volt-amperes consumed in the leads to the meters should never exceed this amount and should preferably be less.

Potential transformers are usually rated at from 10 to 200 watts. The total load in volt-amperes should never exceed the rating and where a high degree of accuracy is required the total load should be considerably less than the rating.

(To be continued.)

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue*. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity" September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas." Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

PACIFIC COAST ELECTRICAL EXPOSITION.

The management of the Pacific Coast Electrical Exposition announces that it will be opened on May 21, 1910, at the new Coliseum in San Francisco. More than enough space has already been taken to assure the success of the show, which has been delayed because of the burning of the Coliseum last winter.

New Work for The Engineer

Foremost among the many new conditions to which we are all necessarily adapting ourselves in this present plastic period are those which have arisen in connection with the supply of certain conveniences to communities. These modern conveniences include transportation, power, light and telephone service which can be developed and furnished most economically by that combination of capital known as a corporation. But because some of these corporations in the past have sometimes been too militant in the strife of competition there has been spawned a feeling of class hatred which loses sight of the fact that civilization is successful only when synonymous with mutual service.

If this widespread prejudice against corporate supply of public utilities continues unchecked, the most radical among the dissatisfied will attempt to substitute a more popular means of supply. As we are yet some centuries short of the millennium, and as our present government is not properly equipped to carry on this kind of work, wise men see impending evils in such a change that are even greater than those that now exist. We desire to hold no brief for the corporation which, under the old policy of "the public be damned," has brought dire calamity upon itself, but we ask at least a fair hearing for other corporations who are willing to give full publicity about all their doings. Most corporations are now willing to do this and more, but find that their good intentions are frequently rudely rebuffed. In time, of course, a good feeling can be established by such means as public service commissions, but this action can be greatly accelerated by a slight effort on the part of the engineer.

The engineer is peculiarly qualified by his training and knowledge to act as a peace-maker between these contending interests. It is he who can best inaugurate a campaign of education, which may well be likened to the propaganda of that great religion which also has as its basis the idea of fellow service and which grows only by mutual co-operation. There are definitions to be made and creeds to be formulated which require the expert attention of the engineer who has made possible the utilization of these natural forces for the needs of man. The average engineer has been too much of a hermit and has not taken advantage of the fact that his word as an unbiased worker is given credence where that of the men financially interested in a project is not. He should, therefore, feel called to go out as a missionary, and "preach the gospel of fairness to capital-invested." He can, by so doing, add his quota of service by which the full measure of success is to be ultimately reckoned. In acquiring his education, the engineer early learned that there was far more in college than books, and in the practice of his profession he should realize that there is likewise far more in engineering than the slide rule. By removing distrust he is preparing the foundations of a structure more lasting than one built of stone and steel.

PERSONALS.

William Goodwin of the Pacific States Electric Company of San Francisco is in New York City.

Leon M. Hall of Hall, Demarest & Co. has been making an engineering investigation near Cloverdale, Cal.

S. N. Griffith, who was one of the promoters of the Fresno Traction Company, is in San Francisco from Fresno.

Leon Bly, secretary of the Butte and Tehama Power Company of Red Bluff, was a recent visitor to San Francisco.

Robert T. Reid, superintendent of the Western Union Telegraph Company in Seattle, Wash., was in San Francisco during the past week.

S. M. Stone, an engineer associated with Hall, Demarest & Co., with headquarters at Virginia City, was in San Francisco during the past week.

F. S. Kenfield, president of the Kenfield-Leach Company, publishers of "Telephony" and other technical periodicals, was a recent visitor to San Francisco.

L. A. Somers, of the industrial and power department of the Westinghouse Electric and Manufacturing Co.'s San Francisco office, is in Bakersfield, Cal.

F. G. Cary, who is interested in electric lighting and water power enterprises, arrived from Lodi last week and remained in San Francisco a short time.

Thomas Collins of the Westinghouse Electric and Manufacturing Company's sales department, is again at his desk in the San Francisco office after a severe illness.

L. H. Conklin has resigned as general manager of the Scranton Electric Company of Scranton, Pa., to become engineer of the operating department of J. G. White & Co. of New York.

Julian Thornley of New York, who recently assumed charge of the construction of the Great Western Power Company's large dam at Big Bend, visited the company's San Francisco office during the past week.

A. C. Sprout has returned from Keeler, Cal., where he went on engineering business for the Four Metals Mining Company, which is developing water power for electric power transmission purposes on Lone Pine creek.

W. E. Warren has purchased the stock of electrical fixtures and supplies of the Smith Electric Company of Blaine, Wash., and has moved his stock from the location on Martin street to the store on Washington avenue.

Francis Hodgkinson, the head of the Westinghouse Machine Company's steam turbine department, left San Francisco this week for a tour of Southern California, accompanied by K. G. Dunn, of Hunt, Mirk & Co.

Clem A. Copeland has resigned as electrical engineer for the Pacific Electric Railway Co. of Los Angeles, Cal., to join the department of operation and maintenance of the Pacific Gas and Electric Co. of San Francisco.

Wynn Meredith, manager of the San Francisco office of Sanderson & Porter, has returned from a trip to New York. He visited Victoria, B. C., where his firm has important work in progress, before going East, and spent a few days in Los Angeles on his way home. He also visited the Pacific Electric Heating Company's large and growing manufacturing plant at Ontario, Cal., while in the southern part of the State.

C. L. Cory, consulting engineer, has returned from a trip to Santa Barbara and Los Angeles. He has been engaged by the city of Santa Barbara to determine upon the proper valuation of the Santa Barbara Gas and Electric Company's plant for the purpose of fixing rates. He secured the necessary data from the local company and the Edison Electric Company of Los Angeles, which is the holding corporation.

W. W. Briggs, Jovian Statesman for Northern California has appointed the following committees: Entertainment—F. H. Poss, A. E. Drendell, F. S. Fowden, and W. S. Hanbridge; membership—W. L. Goodwin, O. B. Gregory, F. D. Fagan, H. D. Boschken; finance—C. G. Hillis, W. S. Berry, T. E. Bibbins, R. D. Holabird. The chairman of each of these committees together with Mr. Briggs are to form a welfare committee.

TRADE NOTES.

The General Electric Company has sold to the Schwager-Nettleton Mills, in Seattle, Wash., two A, T, B, 2, 500-kw., 3,600 r.p.m., 480-v., horizontal, condensing Curtis turbine generator sets.

The St. Louis offices of the contract agent of the Electric Storage Battery Company of Philadelphia, which are now located in the Wainwright building, will be moved on Monday, March 28, 1910, to No. 1205-6-7 Fullerton building, Seventh and Pine streets, St. Louis. Bell Telephone No. Main 2728, Kinlock Telephone No. Central 921.

A contract has been closed for the stranded aluminum wire for the new 40-mile electric transmission line for the Jordan river development of the British Columbia Electric Railway Company on Vancouver Island, near Victoria, B. C. The total length of the wire ordered is about 120 miles. Sanderson & Porter are the engineers, Wynn Meredith being in charge of the work on the Coast. The above order was placed through the Seattle office of Pierson, Roeding & Co.

Jack MacGovern, of MacGovern, Archer & Co., of New York, left San Francisco last week for the East. His firm purchased from the United Railroads six 25-cycle rotary transformers, ranging from 1,000 to 1,650 kw., and six large static transformers. In changing over to the Stanislaus River transmission plant as a source of supply it was found necessary to use 60-cycle current. General Electric motor generators are now being installed in the railroad sub-stations in San Francisco.

Announcement has been officially made that the Electric Storage Battery Company of Philadelphia has acquired all the patents and rights of the Westinghouse Storage Battery Company. The Westinghouse Storage Battery Company owned all the rights of the General Storage Battery Company, and the storage battery interests and patents of the Westinghouse Machine Company. From this time on the Electric Storage Battery Company will have the sole right to manufacture Westinghouse batteries.

On May first the Dearborn Drug & Chemical Works will move their general offices and chemical laboratories from the Postal Telegraph Building, where they have been located since the organization of the company more than twenty years ago, to the new McCormick Building, on Michigan avenue and Van Buren street, Chicago. The extensive growth of the business of the company has made necessary this removal to its new home, where the general offices and laboratories will occupy the greater portion of the top floor of one of the finest office buildings in Chicago. The Dearborn Company will have the entire frontage on Michigan avenue for its offices and laboratories, with a total floor space of more than five thousand square feet.

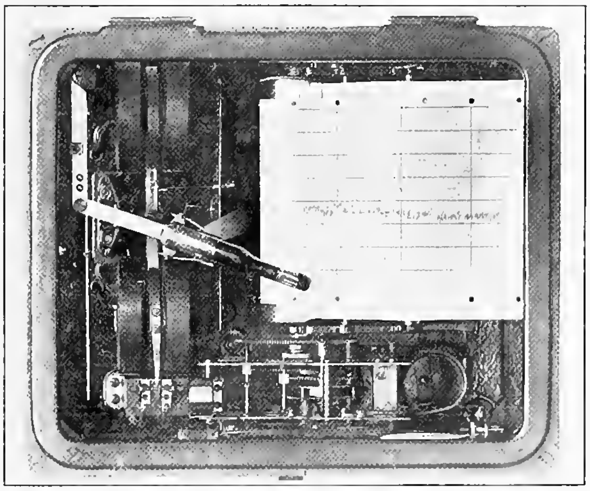
The American Electric Fuse Company of Muskegon, Mich., has just received news of a decision in its favor, filed February 14, 1910, in United States Circuit Court, for the southern district of New York, upon patent No. 521,018, covering double tubed connectors for telephone and telegraph wires. This suit has been pending about six years. Testimony has been taken in a large number of different cities. The subject matter involved was what is known as the American improved double tube connector for splicing telephone and telegraph wires. This connector has been manufactured by the American Electric Fuse Company for the past ten years, and under the decision just rendered in United States Circuit Court, the rights of the American Electric Fuse Company are fully confirmed in all respects.

INDUSTRIAL

RECORDING THE OUTPUT AND LOAD FACTOR OF NEWSPAPER PRESSES ELECTRICALLY.

Among the interesting special applications of graphic recording electrical instruments is their use as speed recorders where some important, continued operation is to be studied with a view to improving its time, efficiency and economy. Several large New York daily papers have had installations of this kind added to their press-room equipments, and are now obtaining complete, continuous records of the operation of their mechanical plants—information which is found very valuable in foreseeing delays and halts during the hurried and important minutes when each paper is racing to be first on the streets with its edition.

Ten-volt magnetos have been used in these instances, being geared or positively connected to the main shafts of the respective presses. When run at full speed, say 250 revolutions per minute, such a magneto is designed to give ten volts at its terminals. Arranged to be connected across these terminals is a ten-volt Westinghouse graphic recording voltmeter, which gives a full scale movement when ten volts is impressed upon its windings. Special record paper is furnished, reading directly in revolutions per minute up to 250 for a full scale deflection. It is evident, therefore, that when the magneto is running at full speed, 250 revolutions per minute, it develops ten volts, and this in turn produces a full scale indication, which is read directly from the scale as 250 revolutions per minute. Intermediate speeds are proportionately and accurately indicated.

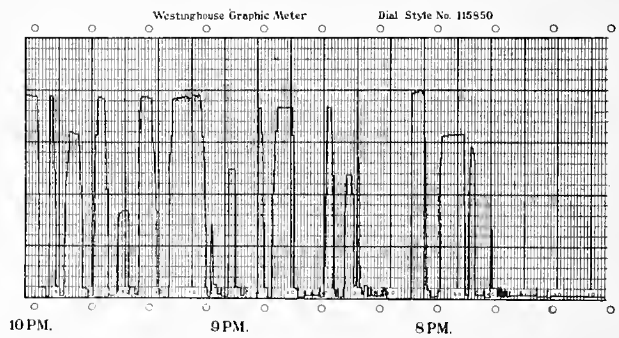


Graphic Speed Recorder.

At the present time one of the best installations of this system is in the printing plant of the New York World, which has sixteen magnetos for recording the speeds of its single and double octuple presses. Each single octuple press is provided with one magneto and each double press with two magnetos, as the two parts can be operated separately. At present there is installed in the World office, in a room two floors above the press-room, a single Westinghouse graphic speed indicator arranged for connection at different times to any of the sixteen pairs of leads from the corresponding magnetos.

Each magneto has an individual complete metallic circuit to the graphic speed indicator; each circuit including a separate voltmeter resistance which has been accurately adjusted to correct the differences in the resistances of the leads, voltages of the magnetos, etc. The lengths of the various pairs of connecting wires vary from 150 to 250 feet, and the voltages of the sixteen magnetos are all within 10 per cent at the same speed. However, the accurate allowance made for each factor by inserting suitable resistance, followed by careful calibration of the indicator in circuit with each magneto, makes the meter reading absolutely dependable for the speed of any of the sixteen presses. To avoid the trouble of changing over connections, and to obtain records of several presses at the same time, each magneto is later to be furnished with its own permanent recording instrument, although this was not done at first in the case of the World on account of the rather novel and experimental nature of the installation.

In the case of the World plant, the full load speed of the press cylinders is about 200 r.p.m., and as the magnetos are designed to operate at a maximum of 1,000 r.p.m., they are geared to the press cylinders at a ratio of 4 to 1 by means of sprockets and chains. When the press is operated at a speed of 200 r.p.m. the magneto is running at 800 r.p.m., and the meter records at a point four-fifths of the distance from zero to the top of the chart.



Graphic Record of Printing Press.

The meter clock is provided with a synchronizing attachment which is controlled from the master clock connected to the Western Union service through a special relay. The master clock is controlled by impulses at one-half minute intervals from the Western Union service, and it in turn controls a large number of clocks installed through the Pulitzer building, in which the World plant is located. The relay is required to give impulses at intervals of one hour for the synchronizing device.

Accompanying is the reproduction of a record recently obtained on a large press in the New York World plant during the printing of an edition. The record speed is four inches per hour, and the irregular line produced by the pen indicates clearly the different operations to one familiar with the action of newspaper presses. For instance, the jogs in the record, indicating a speed of about 10 r.p.m. are caused by threading in a new roll of paper in the press, or by the repairing of a break in the paper due to a choke or excessive tension on the roll from which the paper is fed.

As the result of the success experienced with Westinghouse graphic speed indicators in a number of printing establishments, as well as in an experimental installation in its own plant, the New York Globe and Commercial Advertiser is now putting in a complete system of speed recorders in its press-room.

NEWS NOTES

FINANCIAL.

FREEWATER, ORE.—The City Council has instructed Recorder G. P. Sanderson to call for bids for bonds for the construction of the new waterworks system. The bonds are for $16,000, to run for 16 years with interest at 5%.

OREGON CITY, ORE.—At a recent meeting of the water commission it was decided to install another filter unit to the waterworks which will cost $4,000. The unit to be added has a capacity of 500,000 gallons a day and will increase the capacity to 2,000,000 gallons.

TACOMA, WASH.—Commissioner of Public Works H. J. McGregor has awarded a contract to Bertelson & Sons for the laying of water mains on Canal, River and Twenty-first streets for a bid of $25,800. Bids were also received for laying water mains on East L street, East N street and Portland avenue from South Twenty-fifth to South Twenty-sixth streets, from East L street to Portland avenue. Galluci & De Rose were the lowest bidders, but Commissioner McGregor wished to make an investigation as to the water hydrants to be used before awarding the contract.

INCORPORATIONS.

INDEPENDENCE, CAL.—The Home Telephone Company of Independence, with a capital stock of $14,600, has been incorporated by J. S. Bohannon, J. L. Hanna and W. L. Bica.

SAN FRANCISCO.—The General Electric Construction Company, with a capital stock of $25,000, has been incorporated by G. F. and J. H. Belden and G. A. Sittman, with their principal office in San Francisco.

MODESTO, CAL.—The Tuolumne River Power and Irrigation Company, capital stock $50,000, shares $1 each, has been incorporated by D. A. Jones and G. W. Barnett of San Francisco and C. W. Terry, T. F. McGovern and C. H. Segerstrom of Sonora.

SAN FRANCISCO.—Articles of incorporation were filed with the County Clerk of the Water Supply Company of San Francisco. It is to run for 50 years and has $20,000,000 of capital stock. Of this amount, the seven incorporators each subscribe $100, making the total cash subscribed and paid in $700. Most of the incorporators are clerks, bookkeepers and young attorneys in the office of Lawyer McCutchen, Spring Valley's attorney. Their names are as follows: F. E. Boland, R. H. Kimball, T. A. Allan, J. F. Cassell, H. L. Atkinson, R. A. Wagener, all of this city, and F. H. Markey of Alameda. As set forth in the articles, the purpose of the company is to conduct a general water and water power business. Mr. Bourn refuses to either affirm or deny that he personally or as president of and a director and stockholder in Spring Valley, has any connection with the new concern. When pressed to make some statement in connection with the Water Supply Company he replied: "It is impossible for me to talk at this time."

TRANSMISSION.

DIXON, CAL.—E. D. N. Lehe bid the sum of $50 for a franchise to erect poles for an electric lighting and power system. He was awarded the franchise.

TACOMA, WASH.—Morton Ramsdell, manager of the Seattle-Tacoma Power Company, has announced that the company will spend $500,000 in adding equipments (to generate 10,000 additional horsepower) to its Snoqualmie Falls plant.

LOS ANGELES, CAL.—The Board of Supervisors are receiving sealed bids for a 30-year franchise to construct an electric pole and wire system upon certain public highways in this county.

LOS ANGELES, CAL.—Work on laying the third rail of the Pacific Electric's Glendale line on West Sixth Street is held up to await the arrival of material from the East, and it may be a month before work will be done.

SANTA FE, N. M.—An application for the Rio la Casa power plant has been filed in the office of the Territorial engineer. The applicants are J. J. Laubach, W. G. Benjamin W. B. Bunker and William Harper. The plant is expected to develop 2,745 horsepower and will be about 40 miles from Las Vegas, on Rio la Casa.

LOS ANGELES, CAL.—A corporation known as the Ramona Power Co. has filed on the right to develop electrical power from the water flowing over the Hemet dam. They will build a new dam on the north fork of San Jacinto river. Men behind the power company state that they will develop electricity in the small towns of Hemet Valley. Associated with the power company are Ehrman Grigsby, Roy Jones of Santa Monica, R. M. Miller, MacPherson of Edison Electric Company, and Ben Hunter, an attorney.

BURBANK, WASH.—The Burbank Power and Water Company, which controls a large water power development on the Snake river at Five Mile rapids, has recently ordered from the Allis-Chalmers Company the complete equipment for their second pumping unit, consisting of one Allis-Chalmers twin horizontal turbine, with steel plate runners, to operate under 9-foot head, direct connected, to one 39"x60" Connersville cycloidal rotary pump having a capacity of 70 second-feet through a lift of 55 feet. E. M. Chandler is manager.

TELEPHONE AND TELEGRAPH.

THE DALLES, ORE.—The Dutch Flat residents have organized a telephone company of which John Gaylor is secretary. Considerable construction work will be done.

BAKERSFIELD, CAL.—Permission was granted A. Williamson to construct a telephone line along the south side of the county road near the northwest corner of section 30, thence easterly along the south side of county road.

SAN FRANCISCO.—A bill in equity was filed in the United States Circuit Court by the McCarty Wireless Telephone Company against the Universal Wireless Telephone and Telegraph Company asking for damages for alleged infringement of letters patent.

HAYWARD, CAL.—The residents of the Fairview district, located to the southeast of Hayward, have organized the Fairview Rural Telephone Company in order to obtain an extension of the service to their houses. The officers of the company are: Thomas Nessen, president; P. B. Drake, secretary; Fred Sorenson, treasurer; Fred Cremer and Miss Agnew, directors.

SAN RAFAEL, CAL.—At the meeting of the Town Trustees it was decided to accept the bid of the Gamewell Fire Alarm and Telephone Company for the installation of a first-class fire alarm system in San Rafael. The bid calls for an expenditure of $4,700, for which price the company will furnish the municipality of San Rafael a non-interfering fire-alarm system with 25 boxes, double registers at fire headquarters and an electric alarm risen, which will give warning within a radius of 12 miles.

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Devoted to the Conversion, Transmission and Distribution of Energy

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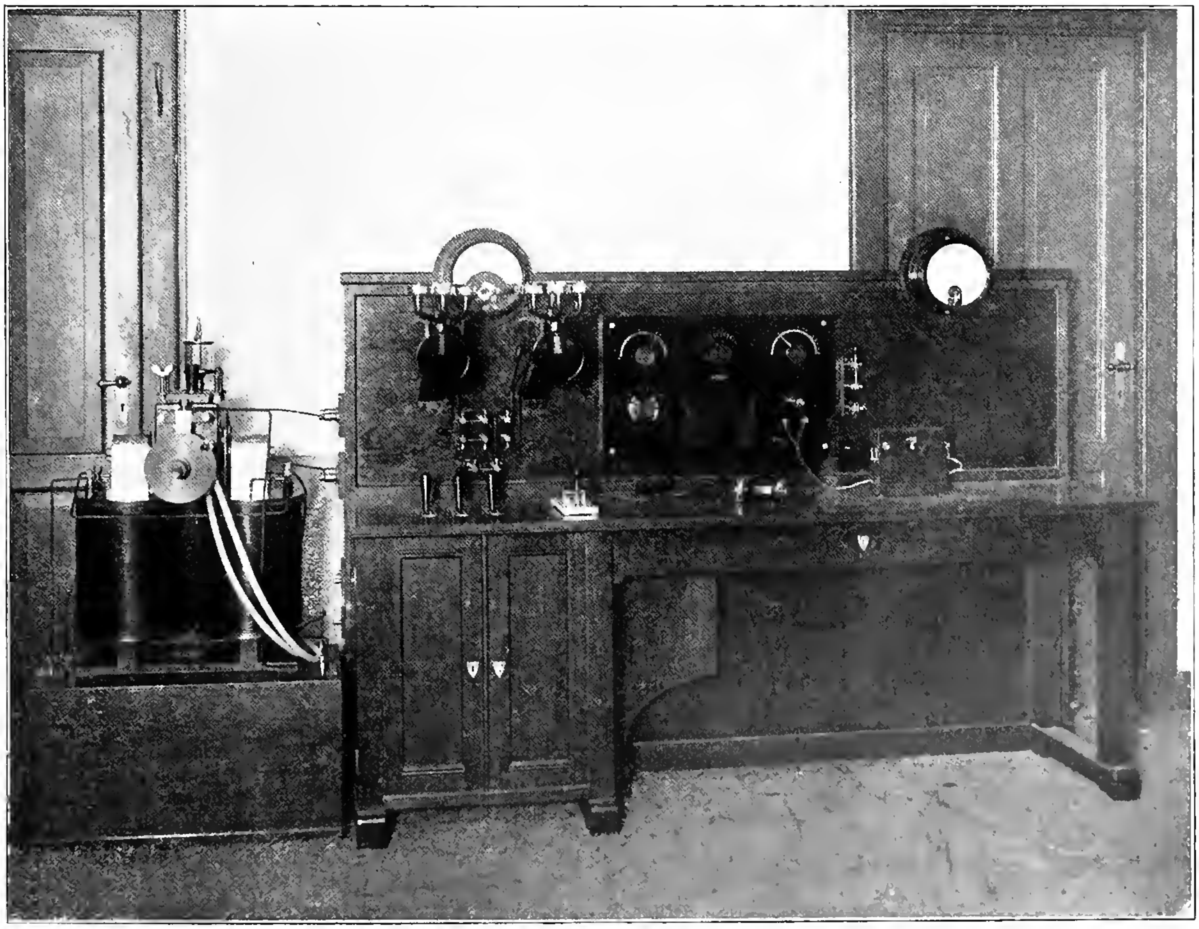
VOLUME XXIV SAN FRANCISCO, APRIL 2, 1910. NUMBER 14

THE POULSEN SYSTEM OF WIRELESS TELEPHONY AND TELEGRAPHY[1]

BY C. F. ELWELL.

As soon as the methods of signaling through space first given to the world by Marconi were well understood, scientists throughout the world recognized the shortcomings of both the transmitting and receiving of large induction coils, in the primary circuit of which a suitable telegraph key was inserted.

Many improvements have been made in this type of transmitting circuit. Commercial transformers



Poulsen Wireless Station.

apparatus. Transmission was first effected by means of strongly damped oscillations generated by means of powerful sparks from condensers charged by means working at a frequency which would give the maximum sensitiveness to the telephone receivers at the receiving station have been substituted for inefficient spark coils. Many attempts have been made to suppress the noise of the sparks, which with the increased

[1]Paper read before San Francisco Section A. I. E. E., March 25, 1910.

use of large amounts of power became distressing to the operator besides betraying the message to unauthorized parties. Apparatus doing this successfully also decreases the efficiency of the apparatus. Keys had to be devised to break the necessarily large primary currents and quite an array of electromagnetic and oil immersed keys are now in use. For heavy power working the speed is limited by such apparatus. Sending condensers have been improved both as to bulk, durability and cost.

Signals were received by means of the Branly coherer on which much time and money were fruitlessly spent. Then came the magnetic, electrolytic and thermo detectors with increased sensitiveness and automatic decohering features. But these detectors have not the well defined resistance which is necessary for accurate resonance tuning effects.

The Danish inventor, Valdemar Poulsen, took up the study of the wireless transmission of signals and recognized the fact that further advance depended on decrease of the damping of the oscillations and increase of sensitiveness of detectors. He determined to follow up the generation of undamped waves as being the line on which more selective telegraphy would be obtained and telephony also be made possible. After a profound study of the "singing arc" following in the footsteps of Elihu Thomson and Duddell, he evolved his present type of arc generator. This generator, with suitable capacity and inductance in shunt to the arc, sets up trains of practically undamped waves of frequencies from two hundred thousand to one million per second according to the values of capacity and inductance in the shunt circuit. Not only this, but he has been able to transform as much as 30 kw. of d. c. to high frequency current in the shunt circuit.

With this generator the solution of the problem of telephoning through space was immediately solved. Applied to telegraphy it gives improved selectivity of the instruments to an extent never reached by spark methods, permits of duplex working, gives great range with small amounts of power, better results over land, better daylight working and, last but not least, a great increase in speed. For the purposes of telegraphy he had to invent a new type of detector which is now known as the "ticker" and which has been shown to be much more sensitive than any other detector. This detector was necessary in order to render the telegraph signals audible because the alternations take place at a speed much above the limits of audibility.

I will take up the pieces of apparatus, which show the mark of Poulsen's genius, in detail and then give you a short indication of the results obtained with them, together with a short note on the theory of action of the generator and ticker.

Arc Generator.

In Fig. 1 is shown a Poulsen generator. The arc takes place between a water-cooled copper anode and a revolving carbon cathode. The anode and cathode project through two opposite sides of a water-cooled chamber. The arc takes place in the presence of a powerful magnetic field at right angles to the flow of current. The coils can be plainly seen and the poles project through the other sides of the chamber. The small motor revolves the cathode very slowly and prevents a deposit of carbon taking place and so shortening the arc gap, which is maintained at from 3 to 5 mm. in length. The chamber is equipped with inlet and outlet for supplying the arc with a hydrogen-containing gas. On the generator shown there is a sight feed oil cup in which alcohol is placed. Drops of alcohol on being introduced into the chamber are immediately vaporized and this method of gas supply is in use on ship board. The mechanism seen to the front of the generator is for striking and adjusting the length of the arc by hand. In the chamber there is a yoke which is attracted by the magnetic field when the current is switched on and a small copper tip serves to strike the arc. This automatic arc striking feature was devised for wireless telephoning, so that talking and listening could be carried on with ease.

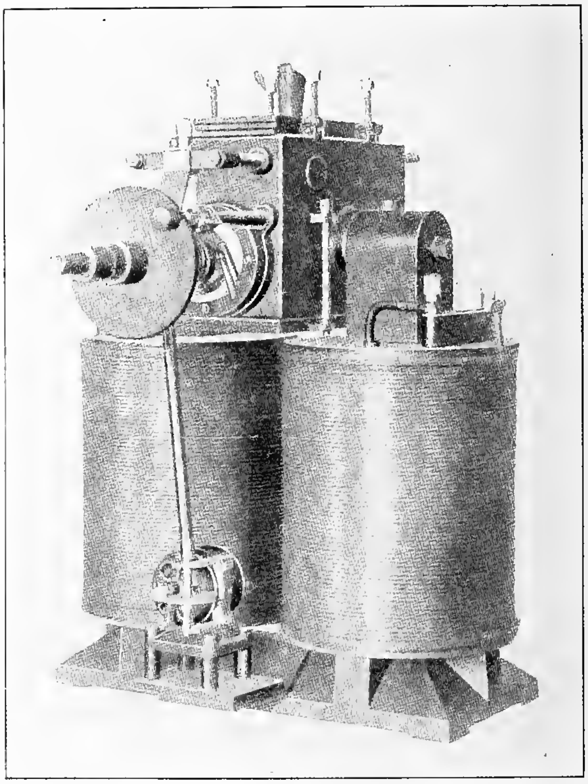


Fig. 1. Poulsen Arc Generator.

A large amount of heat is produced in the water-cooled chamber which is removed by means of the cooling water. A certain amount of power is absorbed in the regulating resistance in series with the arc. Of the power which is converted into high frequency oscillations, part is dissipated as heat in the capacity and inductance and part is radiated by the antenna.

A wattmeter may be used to measure this radiated energy by using a direct coupled antenna and measuring the watts at some point in the condenser circuit with and without the antenna. The difference will be the watts radiated.

Fleming has shown that if W represents the energy in ergs radiated per second, when the oscillations are persistent, $W = 128 A^2$, where A is the current read on a hot wire ammeter. Thus a current of 2 amperes would give a radiation of 512 watts, showing that when working with persistent oscillations and

open antennae, we can use very small antenna currents, and obtain powerful radiation effects.

The generation of high frequency alternations in a shunt circuit to a continuous current arc is somewhat as follows:

If the arc is steady and is then shunted by a condenser, the current rushes into the condenser and momentarily robs the arc of current, causing the potential difference in the carbons to rise and continue charging the condenser. When the condenser is full the arc current returns to its former value, the potential difference falls, and the condenser discharges from the arc, and the cycle repeats itself. A part of the energy of the continuous current arc is thus changed into the energy of electric alternations in the condenser circuit.

The characteristic curve of the arc is, as is well known, a falling characteristic, i. e., the voltage decreases as the current increases, and for a carbon-arc is comparatively flat. It has besides a persistency which renders it irresponsive to rapid variations of current. Hence only slow alternations can be obtained from a large current carbon-arc.

With the Poulsen arc, with its carbon negative and cooled copper positive, immersed in hydrogen, a very steep characteristic is obtained and one which responds to exceedingly rapid variations of current through it. A condenser of small capacity may be employed in the shunt circuit and yet convey to it a considerable amount of energy because of the large variation of the difference of potential at the arc caused by small arc current variations. So alternations of high frequency can be produced.

This theory is confirmed by the study of small current carbon-carbon and carbon-aluminum arcs in air. For they have steep characteristics and can produce alternations of high frequency. The theory of the part played by the hydrogen on large current carbon and metal arcs is not yet well understood. It appears to be partly due to its greater conductivity compared to air, thus helping to cool the arc electrodes. Poulsen also considers that hydrogen increases the conductivity of the arc.

Ticker.

Practically, the ticker consists of nothing but two fine crossed gold wires, which are vibrated at the rate of 100 vibrations per second, by means of an electromagnet or clockwork. This may be connected to a secondary circuit which is coupled electromagnetically with the primary circuit as in Fig. 2, or in many other ways.

The theory of action is about as follows:

A indicates a receiving antenna or aerial circuit from which alternations are induced in the coil B, which, together with the condensers C and D, constitutes a closed resonant circuit; R may be any form of detector but an ordinary telephone receiver is usually used; I is the interrupter mentioned above and is connected to connect condenser E in parallel with condenser D. When the contact at I is open and assuming that the resonant circuit B C D is tuned to resonance under these circumstances, intense alternations will appear in this resonant circuit B C D, without passing through the telephone receiver R, because of its enormous reactance to high frequency alternations. If now the interrupter I closes the circuit and throws in this condenser E the accumulated energy in the resonant circuit B C D will discharge itself suddenly through the telephone receiver R. The reason for this action is approximately as follows:

While the coil A and B are in resonance the condenser C is charged and discharged at a rate corresponding to the frequency of the alternations. B therefore offers no opposition to this charge and discharge but assists it and maintains the intensity of the alternations. If, however, the condenser has a charge when B is thrown out of resonance with A because of the closing of I and the insertion of more capacity E the

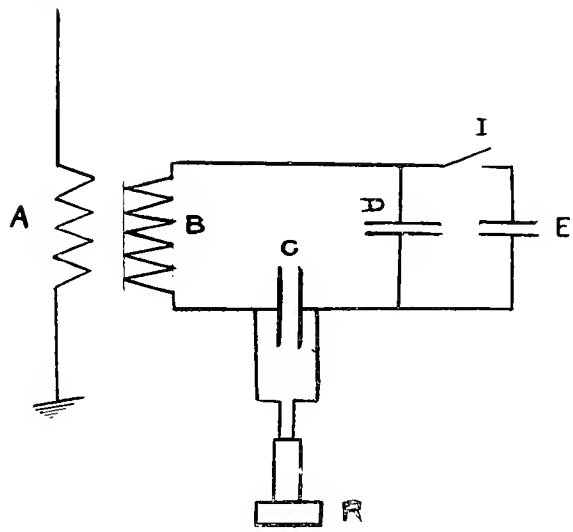


Fig. 2.

discharge of the charge in C will be opposed by B and the charge will have to find another path which it does through R. This discharge takes place in a minute fraction of a second, thus producing a sharp tap in the receiver.

Rapid Telegraph Transmitter.

Fig. 3 shows the rapid telegraph transmitter which is operated by means of a punched tape. The tape has a series of small holes down the center. The holes on each side of this central line are punched by hand and those on one side represent the dots, while those on the other represent the dashes of the Continental code. The central line

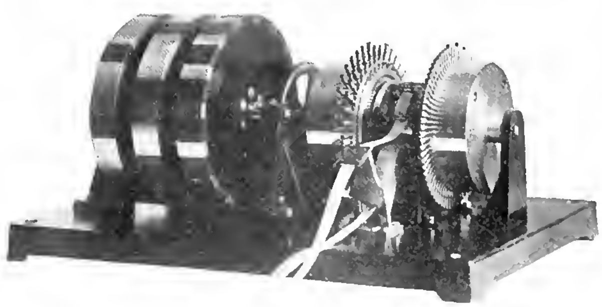


Fig. 3. Rapid Telegraph Transmitter.

of holes engages the teeth of a sprocket wheel which serves to feed the tape forward at a regular rate. The

tape gear wheel has a number of very small and light radial pins, which tend to fly out except when they are held in position by the tape. Wherever a hole occurs a pin is allowed to spring outwards. These pins are mechanically connected to larger pins on a further attachment of the spindle which fly out when the smaller pins are actuated by the tape. Spring contacts are in series with a set of brushes which press on the segments of three rotating commutators, one of which has a comparatively large number of alternate conducting and insulating segments, and is reserved for the dots, while the other two have longer spacings of commutator segments, which are kept for the dashes. In this way all the actual making and breaking of the current is carried on on these larger segments, while the tape controls the whole apparatus by means of the lighest possible form of mechanical construction. This reduces the effect of inertia to the lowest limit. There are 72 pins, each representing a dot and a space. An average word has five letters, so it is possible to transmit three words for one turn of the transmitting combination and the speed of the machine, which is driven by a direct current motor, can be varied between the limits of ordinary hand speed to a transmission of 300 words or more per minute. The practical limit at present being in the receiver and not in the sender.

Rapid Telegraph Receiver.

A complete rapid receiver is shown in Fig. 4. It consists essentially of an Einthoven "string" galvanometer in which a gold string is used in connection with a thermocouple. The absence of inertia permits the string to follow the rapid impulses sent out by the rapid sender. A coating of soot is placed on the wire and the wire itself is mounted in the beam of a Nernst or arc lamp. A suitable optical condenser throws the light on a narrow slit behind which moves a band of photographically sensitized paper. The shadow of a small portion of the wire as it vibrates to and fro in response to the signals from the sending station is thus imprinted on the band, which is then drawn, first through a developing bath, then through a fixing bath, and then through water to wash it. The message may be read on the developed band as soon as it emerges from the light tight box and may be kept as a permanent record. The signals are read above the zero line which is traced by the shadow of the wire when no impulse is present. A short impulse makes a dot and a long impulse a dash.

Wireless Telephony.

The problem of wireless telephony involves essentially three things:

1. The production of undamped or persistent waves in a transmitting antenna.

2. Means for modulating these waves in accordance with the wave form of the spoken voice.

3. Means for detecting the waves at the receiving end and their reproduction into articulate speech.

The Poulsen generator offered a means of supplying the undamped waves in the transmitting antenna and it was only necessary to connect a microphone at or near a node of current in the antenna to supply a means of modulating these waves in accordance with the wave form of human speech.

At the receiving end almost any self-decohering detector will do, but the production of good clear articulation depends quite a little on the degree of coupling of the primary circuit with the secondary circuit. This also applies to the sending circuits in which quite loose coupling is employed.

Poulsen has transmitted good, clear, articulate speech over the 180 miles between Esbjerg and Lyngby, Denmark. Majorana claims to have done 312 miles over water with a specially constructed microphone of his own devising. More recently I have carried on successfully two way working between Stockton and Sacramento, California, a distance of 50 miles over land, and while working between these two stations was heard by St. Helena and Palo Alto, distances of 75 and 85 miles respectively.

There is no doubt that wireless working gives telephony of a higher grade than wire working. There is absolutely no noise in the receiver until spoken words are heard. To one who has talked over long distance wire lines with considerable induction this feature readily appeals. Low resistance receivers are used and expensive high resistance receivers are not necessary.

Wireless Telegraphy.

With the Poulsen generator of continuous waves it is possible to telegraph at hand speed, i. e., 25 words

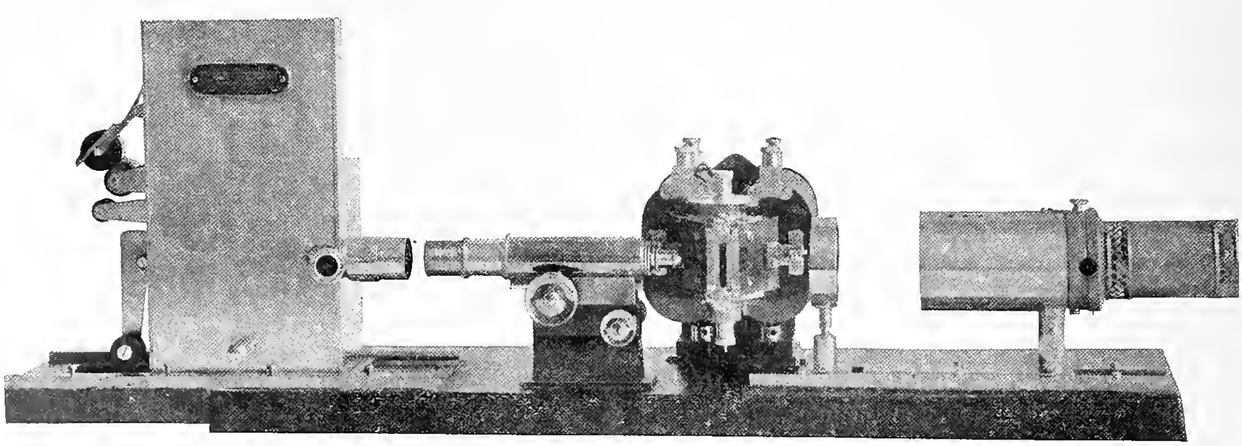


Fig. 4. Rapid Receiver.

per minute in many ways. For example, it is possible to signal by:

(a) Short circuiting a resistance in the generator circuit.

(b) Short circuiting a resistance in the antenna circuit.

(c) Making and breaking the arc.

(d) Altering the length of the arc.

(e) Altering the strength of the transverse magnetic field.

(f) Altering the flow of gas through the arc.

In practice Poulsen short circuits a turn or two of the sending inductance by means of an ordinary Morse sending key. The absence of the spark permits of the use of an ordinary key when telegraphing 2000 miles, for the current is even then quite small.

For receiving, Poulsen uses the ticker which has the great advantage of not being receptive to ordinary damped wave signals.

The tuning possible with the Poulsen arrangement for telegraphy is extremely close. One-half to one per cent change in the capacity of the resonant circuit is readily noticed on the received signals. Duplex working has been carried out with 3.9 per cent change in wave length.

The rapid wireless telegraph transmitter and receiver have already been described. In practice the transmitter is connected in, just where the Morse key would be for hand speed telegraphy. Good, clear, readable records have been received over 180 miles, mostly land, at the rate of 300 words per minute. Over 600 miles good records have been received up to 150 words per minute. As a means for handling large quantities of business and with a record at both transmitting and receiving stations the rapid system has a good future. Poulsen estimates that he can handle 100 words per minute across the Atlantic with a 60 kw. generator and suitable antenna.

Advantages and Future Possibilities.

In the first place the absence of all noise is brought home forcibly in a Poulsen station. It seems hard to believe that anything is being done at all. The key may be of the ordinary Morse type, for the currents handled are quite small even for large distances. There are no insulation difficulties, for the voltage at the top of the antenna is not estimated to be over 3000 volts. The sending helix may be handled quite without shock, even though the voltage be over 1000.

Very small capacities are used with heavy power working, eliminating a source of expense and a very bulky part of large "spark" stations. The capacity in connection with a 12 kw. set is about .0017 microfarad. At the Cullercoats, England, station the condenser takes up less than a tenth of the space occupied by the condensers for a "spark" system of the same power installed in the same stations.

Undamped waves of small amplitude are less obstructed by atmospheric conditions and suffer less absorption over land than damped wave trains. For example, in coming around the north of Scotland the undamped wave signals are picked up long before the damped wave signals of equal power.

The form of the resonance curve of the receiver circuit depends on the decrement of the transmitter and receiver. If the transmitter is undamped, a very small change in the period of the receiver will put it out of tune, hence, a receiver circuit can be employed which is sensitive to undamped waves of some exact period, but which is exceedingly nonresponsive to waves differing by a very small fraction of one per cent in wave length from the syntonic value.

In the matter of energy, good signals have been transmitted over 500 miles with 1 kw., and over 2000 miles with 6 kw., and a limited antenna. The efforts of Marconi and others to reduce the damping of their wave trains is evidence that undamped wave trains will be the means of communication of the future.

In telephony at the present time better articulation is obtainable than with wires and it is quite probable that a method of obtaining secrecy will soon be devised.

In telegraphy there is no doubt that the Poulsen system has great range for little power and that it works readily over land and in daylight. I look to see the present records of distance now held by spark methods broken by stations using the continuous waves. The present speed of the rapid telegraph sender is dependent on the receiver, but a newer type of rapid telegraph detector is coming out which will no doubt result in the handling of greater speed than 300 words per minute. Great advances can be expected in the next five years in wireless working, but they will be along the lines of work with continuous wave trains

GERMAN WATER SOFTENER.

A recent development in Germany of a method, commercially practicable, for rendering hard waters completely soft and preventing boiler incrustations is described by Consular Agent Julien L. Brode.

It consists in a rapid filtering of the water through a composition named "permutit," by which the calcium or lime, manganese, iron, and magnesium compounds, which render the water hard, as well as the microbes it may contain, are, it is claimed, wholly removed, a result hitherto unattainable outside of the laboratory of the chemist, all other processes having left 2 to 3 per cent of these substances in the water.

Permutit is obtained by smelting alumina (clay or argillaceous earth) with an alkaline carbonate (carbonate of sodium) and the addition of quartz. The resulting compound, after having been washed until free from alkali, is a granulous or even laminated soda-aluminum silicate or natrium-zeolith, which is capable of exchanging its entire content of sodium, not only for calcium and magnesium, but also for metals. If, for example, the water to be softened contains in solution lime sulphate or sulphate of calcium, the latter will, when brought into contact with permutit, part with its lime or calcium, which is replaced by sodium, so that there remain in the filter sulphate of sodium and calcium-zeolith. This reaction may be expressed chemically as follows: $Na_2Al_2Si_2O_8+CaSO_4=CaAl_2Si_2O_8+Na_2SO_4$. When the attractive power of permutit for the lime or other substance which renders the water hard has become wholly exhausted, it may be completely regenerated by the use of common salt brine.

Permutit costs about 17½ cent per kilo (2.2 pounds).

THE WATT-HOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

(Continued.)

CHAPTER IV.

THE COMMUTATING TYPE OF WATTHOUR METER.

During the past few years the commutating type of watthour meter has practically been superseded by the induction type for use on alternating current systems, and at the present time its use is principally in connection with direct current work.

The commutating meter (as well as other types) is in reality a direct connected motor-generator, the motor being of the shunt type, having its armature connected in multiple (or parallel) with the source of supply and with its field coils in series with the load to be measured. The revolving aluminum (formerly copper) disc and the retarding magnets comprise the generator. As the disc D, Fig. 44, revolves between the jaws of the retarding magnets M, it cuts the lines of magnetic force, thus producing "Foucault" or "eddy" currents in the disc.

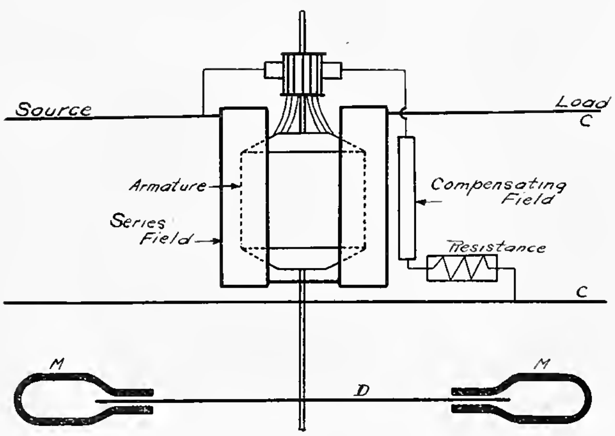


Fig. 44.

Principle of Operation.

The torque, or turning effort, of the motor is proportional to the product of the magnetic flux set up by the armature and that set up by the series field coils. The magnetic flux of the armature is proportional to the impressed e. m. f., and the magnetic flux of the series field coils is directly proportional to the current flowing through them. The product of the current and the voltage equals the power, therefore the turning effort of the armature is directly proportional to the power being expended in the circuit C. The power generated and expended in the disc itself depends directly upon the speed, since the eddy currents generated depend upon the rate at which the magnetic lines are cut, therefore the drag on the disc will be directly proportional to the speed. We therefore have an instrument in which the turning effort is proportional to the power passing through it, and in which the retardation, neglecting friction, is proportional to the speed. Since the speed will increase until the torque just balances the retardation, the revolving element will turn at a speed proportional to the power passing, which is the condition sought. The revolutions of the armature are transmitted through a suitable train of gears to the dials which register in units of electrical work, such as the watthour or the kilowatthour.

Comparison to a Shunt Motor.

There is one essential difference between the ordinary shunt motor and the motor of a commutating watthour meter, and that is the fact that the latter has no iron or steel in its magnetic circuit. If iron were employed in the meter, its torque would no longer be strictly proportional to the current flowing in the series field coils, due to the "saturation" effect of the iron, which would result in a greater reluctance (or magnetic resistance), with an increase in current. Therefore, on light loads, the torque would be correspondingly greater than at full load, thereby causing the meter to over-register on light loads, provided, of course, that it was adjusted to register correctly on full load, or vice versa.

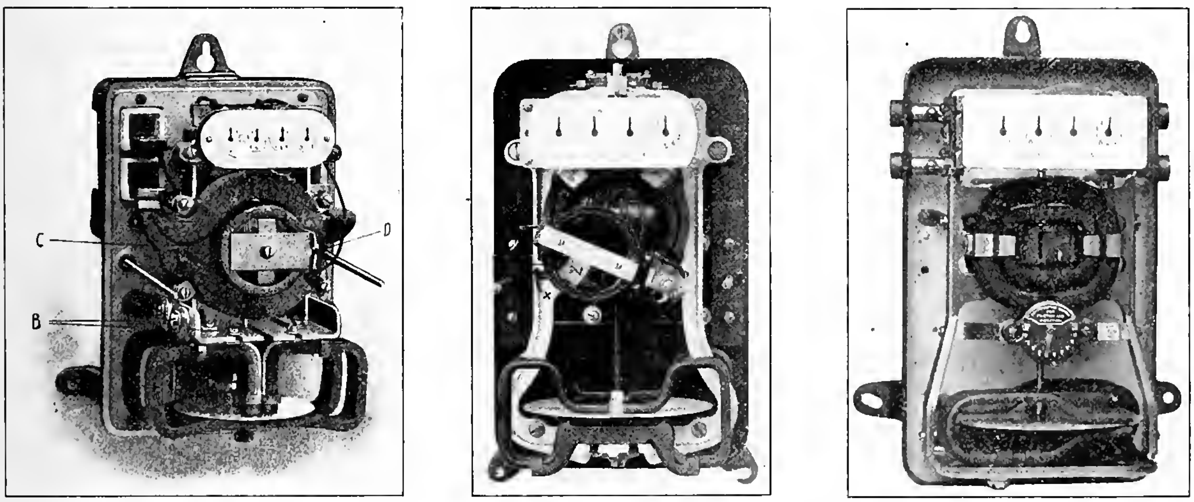
It is a well known fact that the ordinary shunt motor will increase in speed if the field current is decreased, because the armature will then have to run faster in order to generate the "back" or counter e. m. f., under the conditions of a weaker field. On the other hand, a watthour meter will decrease in speed with a decrease in field current, or vice versa. These two facts are apparently contradictory and may be accounted for as follows: The speed of a shunt motor is proportional to the impressed e. m. f., and inversely to the field strength, and must be such that the back e. m. f. is equal (plus the RI drop) to the impressed e. m. f. Any weakening of the field will therefore cause an increase in speed, since the armature conductors have to cut the decreased field at a higher rate in order to generate the same back e. m. f. (For a full explanation of this theory, see any text book on direct current motors.) In the case of the meter, however, the counter e. m. f. is inappreciable, the impressed e. m. f. being practically all absorbed in the resistance of the armature, the auxiliary or "compensating field," and in the external resistance if any is used. So long as the voltage remains unchanged, the armature current will therefore remain unchanged, irrespective of the changes in the series field strength and the speed. The effect of a decrease in field strength is to decrease the torque, with a consequent decrease in speed until the retarding torque exerted by the permanent magnets on the disc is decreased to correspond to the turning effort of the armature. With an increase in field strength the reverse takes place, that is, the reaction between the armature current and the stronger field produces a stronger turning effort which increases the speed until the retarding effect of the permanent magnets increases to a corresponding degree. This condition of the operation of the meter holds true for an ordinary shunt motor until the counter e. m. f. is more than about 50 per cent of the line potential, below which point the speed of the shunt motor would increase with the field strength, and above which point the speed would decrease when the field strength was increased. Thus it will be seen that, in reality, there

is no discrepancy between the motor of a meter and the ordinary shunt motor.

Efficiency.

The efficiency of a meter is based upon the actual watts lost in the resistance of the series field coils and the potential circuit (which includes the armature, the compensating field and the external resistance), the losses due to friction, and the losses in the disc due to eddy currents set up by the retarding magnets.

During the early development of the watthour meter of the commutator type, the loss in the potential circuit alone, in a 100 voltmeter was about 10 watts, and in the 200 voltmeters was about 20 watts; such meters are now termed "low efficiency" meters; the present type or "high efficiency" meter has a loss in the potential circuit of about 4 or 5 watts in the 100 voltmeter, and a loss in the series field coils not exceeding 1 per cent of the total capacity of the meter in the smaller capacity meters and much less than this in the large capacity meters. The reduction in losses has been accomplished by increasing the resistance in the potential circuit and by almost doubling the number of conductors on the armature; the number of armature conductors being increased to produce a greater torque.



a. Westinghouse. b. General Electric. c. Duncan.

Fig. 45.—Types of Commutating Meters.

General Construction.

Fig. 45 illustrates interior views of three representative types of commutating meters, in which (a) is the Westinghouse, (b) the General Electric, and (c) the Duncan, all of American manufacture.

The meter shown at (c) is designed for use on direct current circuits, although it may be said that the Duncan alternating current meter is very similar in construction, and its operation essentially the same as the direct current meter. The use of the commutating type of meter on alternating current circuits will be dealt with later in this chapter.

The Compensating or Shunt Field.

The function of the compensating or shunt field is to compensate for friction, especially at light loads. When a meter is operating on a very small percentage of its rated load, the ratio of friction to torque is relatively great, therefore the lighter the load the greater will be the retarding effect of friction. In order to overcome this friction effect, the compensating field is connected in series with the armature so that its flux will work in conjunction with the main or series field. In the General Electric and Westinghouse meters, the strength of the compensating field is constant, and the "helping out" or compensating effect is altered by moving it closer to or further from the armature, so that more or less of its flux embraces the armature. In the Duncan meter, the amount of compensation is altered by means of the multi-point switch shown in the illustration. This switch is connected to various taps on the compensating winding and the variation is accomplished by cutting in or out a certain number of the coils, thereby altering the flux.

When the compensating field was first used, it was permanently fastened to the inside of the series field coils. This method was soon superseded by mounting it on an adjustable rack, so that it could be moved toward or away from the armature and then clamped in the correct position. The compensating field should be so designed that (in a new meter) it will allow a maximum boosting effect of about 10 per cent on light load, that is, it should have sufficient strength when adjusted for full compensation, to increase the speed of the meter by about 10 per cent when the meter is operating on 5 per cent of full load. This allows sufficient margin for adjustment as the friction increases. With compensating fields designed to give a greater boosting effect, the meter-man is apt to take advantage of the quick method of temporarily adjusting the meter and thereby compensate for excessive friction which by all means should be located and removed.

In the older types of meters (with especial reference to the Thompson recording type), on account of

the low armature resistance, it was necessary to place an external resistance in series with the compensating field, such resistance being mounted in card form on the back of the meter case. This method has been simplified by having the entire resistance of the potential circuit (external to the armature) self-contained in the compensating field in all meters up to and including 250 volts. For the 500 and 600-volt types, it is still the practice to furnish a suitable external resistance for the potential circuit.

Brushes.

It is very important that the brushes be made of a material which will not vary in elasticity, and when once properly adjusted they should maintain their tension permanently. The control of the brush tension is effected either by gravity or by a spring. The actual contact surface of the brush should be made of silver since it has been found from practice that this material gives better service under operating conditions. Each brush (i. e., each positive and each negative) is usually divided into two parts, so as to give a more even distribution of pressure at the point of contact, and to make the brush self-aligning. Brush friction has been considerably reduced by using a cylindrical rather than a flat type.

The Commutator.

During recent developments in the manufacture of meters, the diameter of the commutator has been materially reduced, and at the present time some makes employ a diameter of less than one-tenth of an inch in meters of 110 and 220 volts capacity. This reduction in the size of the commutator has greatly reduced the friction of that particular member. It is general practice to make the commutator bars of pure silver, since this metal suffers least from oxidization, and therefore it presents a smoother surface and more constant contact resistance, two features which are desirable. The commutator is usually built up directly on the shaft, the bars being insulated from it and from each other and are held intact by a metal ferrule on each end of the commutator, the ferrules, of course, being properly insulated from the bars. In some cases the commutator bars are insulated from each other by fibre bars or other solid insulating material, and in other cases simply by an air space. Each of these methods, under certain conditions, are liable to give trouble. When a hard insulating material is used, it is apt to wear down slower than the commutator bars, causing the brushes to "ride," and thereby opening the armature circuit, which will either cause the meter to stop or else cause severe sparking. In case a soft material is used it is apt to gum the commutator and give rise to the same trouble as too hard an insulation. The trouble due to air-insulated bars, is that under extreme conditions, the air space may become filled with dust and small particles of metal, thereby causing adjacent bars to become short-circuited. A meter should be inspected often enough, though, so that under average commercial conditions the commutator with air-space insulation will give good service and will very probably be superior to the commutator with solid insulation.

The Armature.

There are two general types of armature construction at the present, the spherical and the rectangular. The tendency is to favor the spherical type, since this construction permits the field coils to be so designed as to allow a minimum leakage of magnetic flux, thus securing the highest possible torque for a given watt loss in the fields and armature windings, and thus approximating more nearly the condition of an ideal meter.

In both the spherical and the rectangular wound armatures, the winding is of the well-known "Siemens drum type." The rectangular winding is usually supported by two spiders made of small strips of hard wood and properly secured in position on the shaft. The supporting medium in the spherical wound armature consists of two hemispherical pieces of fibre which are mounted directly on the shaft, the windings themselves being held in position by grooves which are stamped in the fibre shells. This construction is good mechanically and insures a very light weight of moving element. The full load speed of the commutating type of meter is usually about 40 r. p. m., which further permits of very light armature construction.

Generally speaking the armatures of meters for use on 110-volt circuits or thereabouts usually have 8 armature coils of about 1000 turns each, of number .003 copper wire, and those of 200 volts and above have 16 coils of 500 turns each, of the same size wire. This method of subdividing the coils on the higher voltages is followed so that there will not be such a great difference of potential between adjacent coils nor between the commutator bars. There is one commutator segment per coil, for instance, in a 100-volt meter there will be 8 commutator segments, and in a 200-volt meter there will be 16 segments.

The total armature resistance in meters from 100 volts to 600 volts inclusive, of the ordinary house type, is usually between 1000 and 1200 ohms, the proper amount of resistance being placed in series to limit the current on the various voltages. The armature current is practically the same for all voltages from 100 to 600 inclusive, the total resistance of the potential circuit being subdivided approximately as shown in the table below:

TYPE OF METER	Shunt Field Resistance	Armature Resistance	Total Resistance	Total watt Loss Potential Circuit	Armature Current Amperes
5 amp., 2 wire, 110 v.....	1,300	1,200	2,500	5	0.0447
5 amp., 2 wire, 220 v.....	3,800	1,200	5,000	10	0.0447
5 amp., 2 wire, 550 v.....	10,900	1,200	12,100	25	0.0454

It is thus seen that the armature current is practically constant.

While on the subject of armatures, it should be borne in mind that the temperature coefficient of the armature and the disc should be the same, so that any decrease in torque of the armature, due to a rise in temperature, will be correspondingly offset by a rise in resistance of the disc, which in turn would decrease the effect of the retarding magnets.

Other features of construction have been dealt with in Chapter I.

(To be continued.)

STEAM

DISCOVERY, PRODUCTION AND TESTING OF FUEL OIL.

BY R. F. CHEVALIER.

The existence of petroleum in the State of California was known to the early settlers who utilized as fuel the seepage found in the southern part of the State. Active operations in the drilling for oil dates back to 1865, when a number of wells were sunk in various counties. The only actual production was in Ventura County. The production of oil varied until 1900, when it began a steady increase, and at the present day is used almost entirely as the fuel for the Pacific Coast. In 1908 the total production of oil was 48,306,910 barrels.

Production.

There are three principal oil-bearing districts in California, located as follows:

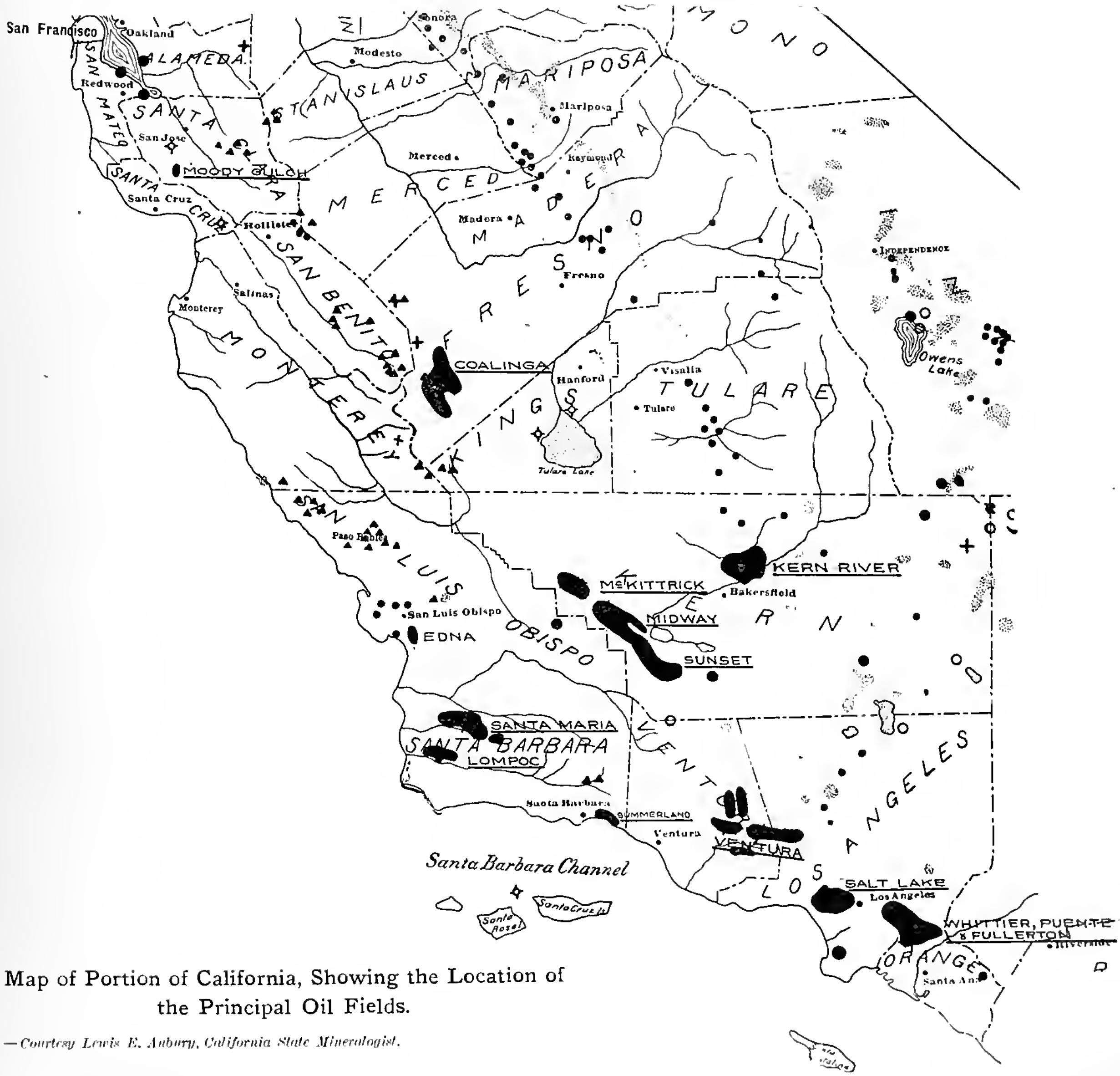
(1) On the west side of the San Joaquin Valley. Here are the Coalinga, McKittrick, Midway, Sunset and Kern River, or Bakersfield, districts.

(2) On the coast in Santa Barbara County, where we find the Santa Maria, Summerland and Ventura fields.

(3) In the vicinity of Los Angeles, the Whittier, Fullerton and Puento fields.

Taking the State as a whole, the oil produced probably averages about 22° gravity. About three-fourths of the production has to be treated before it is fit for use as fuel. This treatment is known as "topping" and consists in removing the lighter distillate, producing, according to the grade of the crude, gasoline, benzine, engine distillate and kerosene.

The transportation of oil from the fields to the market is accomplished by means of pipe lines, tank steamers and tank cars. The use of the latter is rapidly diminishing. Pipe line oil is usually tanked in quantities, and is much more likely to be free from sediment and of more even quality than tank-car oil, which is pumped just as it comes from the small



Map of Portion of California, Showing the Location of the Principal Oil Fields.

—*Courtesy Lewis E. Aubury, California State Mineralogist.*

field tanks where there is little chance to average it.

The pipe lines are six and eight inches in diameter. The pumping stations are from 18 to 30 miles apart, according to the diameter of the pipe, and strength of the pumps and line. The heavier oils are heated at the stations to facilitate handling by the pumps and to reduce the friction in the pipe line. The Southern Pacific Company has finished a rifled pipe line. In to this pipe the oil will be pumped and a small per cent of water added. Due to the rifling, this mixture receives a whirling motion, and the water being heavier than the oil is kept by centrifugal force next to the wall of the pipe, causing the oil to be surrounded by a film of water, thereby reducing the friction.

The Valley oil is found in all grades from the extremely heavy to about 30° Beaume. Most of the oil is heavy enough for fuel purposes in its natural state. The bulk of this oil comes to San Francisco by pipe lines and tank steamers. From these fields are three pipe lines to the coast and two up the valley. Some of the oil is still shipped in tank cars, but very much less than two or three years ago.

Coalinga oil is found from 13° to as high as 34°. Most of the fuel oil production is about 16° average. The lighter oil is largely used for refining. The average for the entire production would probably be 17.5° to 18°.

The McKittrick oil runs from 12° to 20°, but the larger part of the production is 15.5° and 18°.

Midway oil runs from 15.5° to probably 30°. No average can be given, as there is a great deal of new production of unknown quality. Much of this new oil appears to be refining oil, and has to be greatly reduced to make it fit for fuel.

Sunset oil runs from 12° to 20° and probably averages about 17°. The lighter grade needs to be topped before it can be used as fuel. The Kern River or Bakersfield oil runs from 13.5° to 16.5° and averages about 14.5°. All of this oil is fit for fuel as it comes from the settling tank.

The oils from Santa Barbara County are mostly light. These oils reach the coast by pipe lines where some are treated. The bulk of the crude and the residuum from the treated oil are then transported by tank steamers from Gaviota and Port Harford to San Francisco and other markets.

Though the Santa Maria oil is light, it does not refine very well. The heaviest oil from this field is in the east end, where it runs about 15°. The lightest is close to 30° and the average about 22°. Ventura oil is mostly light, though some runs as heavy as 14°, and from this to about 30°. The bulk of this oil is refined for other products and does not come into the fuel market.

The Los Angeles oil comes from Los Angeles and vicinity and all of the product is used locally in the refineries and as fuel. The gravities of the oils from these fields are as follows: Los Angeles City oil, about 15°; Whittier, 16° to 30°; Fullerton, 15° to 34°; Puente, 20° to 35°. The oils lighter than 20° are all refined, most of the oils heavier than this are suitable for fuel in the raw state. Some of the oil from this district is particularly suited for making lubricants.

The Standard Oil Company has an enormous refinery at Point Richmond. They take the lighter oils and reduce them to about 15.4° gravity, and this residuum is marketed as fuel oil. From the distillate they make gasoline, benzine, engine distillate, and kerosene. The lubricants and gas oils come in the portion of the oil which goes into heavy fuel, and therefore are made from oil which is not to be used for this purpose, but is selected for its lubricating value.

The Associated Oil Company has a refinery at Gaviota, where the Santa Maria crude, averaging about 24°, has the gasoline and some kerosene taken off, leaving the oil from 18° to 20°. They do not make any finished products.

The Union Oil Company has a similar but smaller plant at Port Harford. They have a large refinery at Oleum, at which they make fuel oil and a general line of products, and also a plant at Bakersfield.

All the refineries at Bakersfield make an asphalt and a fuel distillate which is used by the pipe line companies in lightening some of the very heavy crude.

Sampling.

Care should be exercised in collecting samples to be tested. When oil is received in large amounts, as from barges or steamers, a small nipple should be inserted in the discharge pipe in some convenient location and small quantities of oil drawn off at regular intervals while receiving. As the samples are taken they are placed in a large container and the whole thoroughly mixed, this method insuring an average of the oil received. From this aggregation the sample for testing is taken. This should be at least one quart, as it is often desirable to make more than one determination of the water contained, also of the flash point. The container should be clean and thoroughly dry and have no trace of gasoline nor kerosene. It should not be filled completely. Room should be left so that by shaking, the oil may be thoroughly mixed before any is removed.

If the above method of collecting the sample is not convenient, and the oil is received in tank car or wagon, then equal portions should be obtained from the top, middle and bottom of the tank. The portions are then mixed and placed in a bottle or tin. A "thief" is used for taking samples in this manner. This is a cylindrical vessel about 10 or 12 inches long and 1½ or 2 inches in diameter. A foot or flap check valve is at the lower end, the upper end remaining open. In lowering into a tank of oil the valve remains open and closes automatically when the apparatus is raised, thereby securing a sample at whatever point is desirable.

Testing.

Of immediate interest to the consumer are the following properties:

Gravity, flash point, water content and heat value.

Gravity.

By gravity is meant the ratio of the weight of a certain bulk of oil to the weight of an equal bulk of water. There are several methods of determining the gravity. Usually it is expressed in degrees

Beaume. There are two types of Beaume instruments, one for measuring liquids heavier than water, the other for measuring liquids lighter than water. Both have the same scale markings, and this gives rise to considerable confusion at times. When finding the gravity of oil, the latter hydrometer is always used, as oil is lighter than water, and therefore there is no chance for confusion.

In marking the scale on these instruments, the one for lighter than water measurements is placed in a solution of 90 parts water and 10 parts salt. The point on the stem coinciding with the level of the solution is marked zero. The instrument is then placed in pure water which establishes the 10° mark. The graduations are then continued until the 100° mark is reached.

The gravity of an oil should be taken at 60 degrees Fahrenheit. If the temperature is not 60 degrees F. a correction must be applied, which gives accurate results only when the coefficient of expansion of the oil tested is known. For all practical purposes it is sufficient to subtract 1 degree Beaume from the observed reading for every 13 degrees Fahrenheit above 60 degrees, or add if the temperature is below 60 degrees Fahrenheit. All hydrometers should be standardized, for the different instruments vary considerably.

The specific gravity may be determined by picnometers or gravity bottles holding a known weight of water at a given temperature. When filled with oil these are weighed on a balance, and the ratio of the weight of water and oil gives the specific gravity.

Balances are made which determine the specific gravity by use of a float of such weight that the beam may be brought to a level when the float is submerged in pure water. Oils being lighter, the float sinks in these, and this tendency must be overcome by the manipulation of weights, the beam being so graduated that the specific gravity may be read directly in decimals. The Westphal is the most popular form of this type of balance, and should be used in all cases where accurate results are desired.

For converting degrees Beaume at 60° Fahrenheit to specific gravity the following formula is used:

$$\frac{140}{130+\text{degrees Beaume}}=\text{specific gravity}$$

or for specific gravity at 60° Fahrenheit to degrees Beaume:

$$\frac{140-130\ (\text{sp. gr.})}{\text{sp. gr.}}=\text{Degrees Beaume.}$$

Before determining the specific gravity of oil, the water should be allowed to settle out, otherwise the results will be incorrect.

Flash and Fire Test.

The temperature at which an oil gives off inflammable gases is called the Flash Point. These gases when mixed with the proper proportion of air form an explosive mixture. As the temperature increases the gases are given off more rapidly until a point in temperature is reached where the oil ignites and continues to burn. This is called the Fire Point. The flash points of oils vary. Oils of the same gravity may have different flash points. The flash point ranges from 350 degrees Fahrenheit down to 60 degrees Fahrenheit. An oil used for fuel should not flash below 150 degrees. Where steam or air is used as an atomizing agent, the oil should not be heated within 30 or 40 degrees of its flash point.

The "open cup" tester is generally used for determining the flash and fire points of crude and fuel oils. A small cup, preferably of iron, about 1½ inches deep and 2 inches in diameter, tapering slightly towards the bottom, is so filled with the oil to be tested that when the oil is heated its surface will be about ⅛ of an inch below the brim. Heat is applied so that the rise in temperature will be about 5 degrees Fahrenheit per minute. The bulb of the thermometer should be just immersed in the oil. As the temperature rises a lighted taper is passed over the surface at intervals of 2 degrees rise in temperature. Care must be taken not to linger with the taper or the results will be incorrect.

The spreading over the surface of the oil of a blue flash, indicates that the flash point has been reached. Continuing the test until the oil ignites and continues to burn is called the fire test.

In lieu of the taper an electric spark may be used. The spark should be ¼ of an inch above the oil, and should not be too strong, as this would influence the results. Results can be made to vary widely. Care should be taken that there are no drafts when making these tests.

Water Determination.

When purchasing fuel oil, unless an allowance be made for the water contained, the purchaser not only pays for water but has another loss in reduced boiler efficiency. When the oil is burning, the water is sprayed into the furnace and passes out with the gases as superheated steam, carrying off the heat units that would otherwise have been imparted to the water in the boiler.

There are three methods of determining the water in oil. These are by gasoline, centrifuge and distillation. The gasoline method is absolutely unreliable. The centrifuge is practically correct, but for accurate results, the distillation method should be used. Comparative tests of the gasoline and distillation methods will be given so that the reader may draw his own conclusions as to the value of each.

Gasoline Method.—One hundred cubic centimeters of the oil to be treated is placed in a graduated sedimentation tube with 100 cubic centimeters of gasoline. The mixture is thoroughly shaken and left to stand for 24 hours, when the water that has settled to the bottom can be read. Gasoline when mixed with California crude oil separates in an apparent spongy form, being in reality a flaky black or brown substance called sludge. This is asphaltine, a solid substance, which normally remains dissolved in oil and which has practically the same value for fuel as any other part of the oil. This sludge makes it difficult to read the true per cent of water.

Centrifuge Method.—A mixture of 25 cubic centimeters of gasoline and 25 cubic centimeters of carbon bisulphide is made in a graduated tube of 100 cc

capacity, the closed end of which is conical, 50 cc of the oil to be tested is poured into the tube and the whole thoroughly mixed. The tube is then placed in an aluminum case attached to a centrifuge and rotated at a high speed for twenty minutes. To prevent breakage of the tube, the aluminum case should be partly filled with coal oil to act as a cushion. The volume of water collected in the conical end of the tube may be accurately read. This volume multiplied by 2 gives the per cent of water in the oil.

Distillation Method.—In a graduated cylinder is placed 25 cc of benzole and 50 cc of the oil to be tested, the whole thoroughly mixed and placed in a still. The graduate is then rinsed out with 25 cc of toluene which is also added to the still. Connection is made between the still and a condenser. The still is heated to a temperature of about 250 degrees Fahrenheit, the distillate is collected in a graduated tube and the volume of water in cc multiplied by 2 gives the per cent of water in the oil. Using a mixture of benzole and toluene hastens the distillation. The benzole comes over first, then the water, and the toluene coming over at a higher temperature than 212 degrees F. cleans the condenser of any water that may adhere to the sides. This method insures very accurate results.

Viscosity.

Viscosity is a measure of the comparative ease with which the molecules of the oil move among themselves. It is determined by noting the length of time taken for a definite volume to flow through an orifice of definite size. If the length of time be measured for any volume of water to flow through the orifice, and this be divided into the length of time that it takes the same volume of oil to flow through the same orifice, both determinations being made at the same temperature, we have what is called the specific viscosity. Change in viscosity on heating the oil is more marked than the change in gravity.

(To be continued.)

WHICH SIDE OF A BELT SHOULD BE IN CONTACT WITH THE PULLEY.

Authorities differ as to which side of a belt should be in contact with the pulley. In order to arrive at some definite conclusion, a series of thirty tests was carried out by Y. Sekiguchi, and the results recently given in an article in The Mechanical Engineer.

The test pieces, which were 1 inch wide, were taken from the same belt and were tested in a 50-ton Buckton testing machine reading to hundredths of a ton.

From the results it is seen that the hair side of a belt is more elastic than the flesh side, but that the latter is stronger than the former. The flesh side, moreover, has been found to have a higher coefficient of friction on the pulley surface. It is therefore generally preferable to have the flesh side of the belt in contact with the pulley. When, however, the pulleys are fairly large and their diameters do not differ greatly, the question of flexibility is not so important; and in this case it would seem best to put the hair side of the belt on the pulley, keeping the stronger, or flesh, side away from the rubbing action of the pulley, and thus prolonging the life of the belt.

PRACTICAL MECHANICS.

PAPER No. 11.

Transmission of Power by Wire Rope.

When it is required to transmit power over long distances up to several thousand feet, wire rope is used instead of belting. The rope runs on large diameter grooved wheels at high velocities. The journal friction is small owing to the large diameter of the sheaves, and if the systems are properly designed idlers to support the cables are unnecessary. The efficiency of a well designed rope transmission system is fairly satisfactory.

The span is usually long enough so that the weight of the rope produces sufficient tension to give the necessary frictional resistance on the sheaves for transmitting the required power. In case of short transmission artificial means are necessary to provide sufficient tension, while if excessive spans are considered the tension becomes greater than is permissible.

In order to keep the necessary tension to a minimum and yet to obtain sufficient frictional resistance the bottoms of the grooves are lined with rubber and leather filling. These are inserted alternately into the groove, which is slightly dovetailed at the bottom and the cable runs on these sections entirely, not coming into direct contact with the sheave.

When called upon to design a rope transmission system the quantities given, or which may be assumed, are the horsepower, the span in feet between driving and driven sheave, and the velocity of the rope. This latter is sometimes fixed by the size of the sheaves permissible but may usually be assumed.

The horsepower transmitted is directly proportional to the rope velocity V and to the difference in tension T, between the driving and driven sides of the rope. It is expressed as:

$$\text{H.P.} = \frac{V\,T}{33000} \text{ or } T = \frac{\text{H.P} \times 33000}{V}$$

From this equation, then, we may immediately find the tension which is doing work, i.e., the difference in tension between the tight and loose sides of the belt, or $T = T_1 - T_2$.

It has been found in practice that the ratio $\frac{T_1}{T_2} = \frac{2}{1}$ is most satisfactory.

This value includes the safety factors of both strength and slip. From this ratio T_1 may be found, since $T = T_1 - T_2 = \frac{1}{2} T_1 = T_2$.

When the rope is at rest the tensions in the two sides are approximately equal and are

$$T_A = \frac{T_1 + T_2}{2} = \frac{3}{4} T_1.$$

This average tension T_A is the tension to which the rope should be drawn up before splicing.

To find the size and weight per foot of wire rope having a maximum allowable tension equal to T_1 we must consult a standard table.

There is another consideration of which account has to be taken in designing wire rope transmission

systems, and this is the allowable bending of the rope when going around the sheave. To insure against deterioration due to this cause the sheave diameter should never be less than 100 times the rope diameter for steel wire and should be 180 rope diameters for iron wire.

Thus far we have taken no account of the length of span or the allowable sag. The tension will depend upon the span and the sag, as well as the weight per foot of the rope. If the sag is decreased the tension will increase rapidly and if the span is increased the total weight of rope is increased approximately twice as fast.

To predetermine these quantities, then, is advisable.

It can be shown mathematically that if:
y = the sag at the middle of the span,
s = the span in feet,
T = the tension,
w = weight of rope per foot, then $y = \frac{w s^2}{8 T}$.

From this formula the sag for any span of given rope may be found for the required tension.

This gives us all the data for the complete calculation of a system. In order to show the application of the foregoing, an example may be worked out.

Let us assume that a span of 300 ft. exists over which we wish to transmit 100 h.p. We may assume a rope velocity of 4000 ft. per minute. Then the unbalanced tension:

$$T = \frac{33000 \times H.P.}{V} = \frac{33000 \times 100}{4000} = 825 \text{ lbs.}$$

This is also equal to T_2, the tension on the loose side when running. $T_1 = 2\ T_2 = 2 \times 825 = 1650$ lbs., the tension on the tight side of the belt when running.

$$T_A = \frac{1650 + 825}{2}\ 1237 \text{ lbs.,}$$ the tension in either side when at rest.

The tables give 9/16 in. as the diameter of a 19 wire rope which will stand a tension of 1650 lbs., and the weight of such a rope is .44 lbs. per foot. The deflection at rest is

$$y = \frac{w\ s^2}{8 \times T} = \frac{.44 \times 300^2}{8 \times 1237} \text{ or } y = 4 \text{ feet.}$$

The deflection at full load may also be found

$$y_1 = \frac{.44 \times 300^2}{8 \times 1650} = 3 \text{ feet for the tight side,}$$

$$y_2 = \frac{.44 \times 300^2}{8 \times 825} = 8 \text{ feet on the loose side of}$$ the belt.

Based upon their very extended experience, the John A. Roebling's Sons Co. have adopted a standard deflection of 1/36 of the span. This is somewhat more than the above assumed case and the Roebling practice is therefore easier on the cable. Adopting this standard sag also permits the use of lighter ropes and the installation will therefore be more substantial, although the tendency for the rope to swing would be greater.

It would be necessary to use sheaves of greater than 5 ft. in diameter in order to prevent the loose side of the rope from swinging against the lower tight side. In a transmission of this size it would be well to use at least a 10-ft. in diameter sheave and this would have to operate at 127 r.p.m. to run the rope 4000 ft. per minute.

If it were not permissible to operate the rope at such high velocity, then a greater tension would be necessary. This would require a heavier rope, and probable less sag, since the weight does not increase as rapidly as does the permissible working tension.

The rope which is employed for transmission is usually composed of six strands of 7 wires each, enclosing a hemp center. Sometimes a rope with 19 wires to the strand is preferable. The wire in the 7-wire strand is about 1 2/3 as large as in the 19-wire rope and will therefore stand more wear. On the other hand, the 7-wire rope requires larger sheaves, since it does not bend so readily.

The ropes are made of iron, cast steel, or plough steel. Usually the weight necessary to produce the required tension is such that a very strong rope is unnecessary, and for this reason iron rope is often satisfactory. If a smaller steel rope is used it will, of course, be necessary to stretch it tighter to gain the required tension. This throws a more intense strain on the filling of the sheaves, causing it to wear more rapidly.

The bending stresses above mentioned, as a rule, exceed the stresses due to the tension, and in order to obtain a good life to the rope these stresses must be carefully considered.

Owing to the high speed of the rope it has a tendency to sway and jump the sheave, both of which momentarily increase the stress greatly. If the sheaves are comparatively small, this extra tension combined with the bending stresses sometimes strains the rope beyond the elastic limit of the iron. This soon causes the wires to crack and rapidly reduces the ultimate breaking strength of the rope.

When the distance to be covered exceeds the length of an average span, one of the two following systems is employed: First, a single loop of the required wire supported at the necessary intervals by idlers is used. These supporting sheaves are spaced far enough apart to give the required tension at the end sheaves. The second system has one loop of rope passing over a driving and driven sheave only, as in our above example, no idlers or guide pulleys being employed; the driven sheave being attached directly to a driving sheave for a second span, and so on. This process may be continued up to two miles or more. The intermediate sheaves are often double grooved and are of a uniform size throughout the system.

Where a single loop of wire is used for a complete long space, and supporting pulleys or idlers are employed, the system is more liable to give trouble than where the shorter loops and no idlers are used.

In some instances it is preferable to install an idler in the middle of a span rather than shorten the span. In such cases it is usually required to decrease the sag and hence a heavier rope is necessary.

Tighteners are sometimes used to increase the

tension on short spans, but in general they are not to be recommended. It is much better to use a heavier rope or possibly a belt.

After a new rope has run for a short time the initial stretch increases the length such that it must be drawn up again to the "at rest" tension and re-spliced. This should not be necessary more than once, however, and additional future stretching should be carefully looked into, as it is a sign that something is wrong. Probably too much tension is being put on the rope and a heavier one should be substituted.

In the long, single loop system some method of taking up the stretch may be necessary. There are several devices for taking up the slack without re-splicing. They usually have the driving sheave mounted on a frame which can be taken up like an ordinary motor belt tightener.

TABLE

Standard Iron and Steel Hoisting Ropes, John A. Roebling's Sons Company

WIRE ROPES OF 19 WIRES TO THE STRAND

Trade number.	Diameter.	Circumference.	Weight per foot in pounds.	Iron: Breaking strain in tons of 2000 lbs.	Iron: Working load in tons of 2000 lbs.	Iron: Circumference of new Manilla rope of equal strength.	Iron: Minimum diameter of sheave in feet.	Cast Steel: Breaking strain in tons of 2000 lbs.	Cast Steel: Working load in tons of 2000 lbs.	Cast Steel: Circumference of new Manilla rope of equal strength.	Cast Steel: Minimum diameter of sheave in feet.
1	2¼	6¾	8.00	74	15	14	13	155	31	—	8½
2	2	6	6.30	65	13	13	12	125	25	—	8
3	1¾	5½	5.25	54	11	12	10	106	21	—	7¼
4	1⅝	5	4.10	44	9	11	8½	86	17	15	6¼
5	1½	4¾	3.65	39	8	10	7½	77	15	14	5¾
5½	1⅜	4⅜	3.00	33	6½	9½	7	63	12	13	5½
6	1¼	4	2.50	27	5½	8½	6½	52	10	12	5
7	1⅛	3½	2.00	20	4	7½	6	42	8	11	4½
8	1	3⅛	1.58	16	3	6½	5¼	33	6	9½	4
9	⅞	2¾	1.20	11.50	2½	5½	4½	25	5	8½	3½
10	¾	2¼	0.88	8.64	1¾	4¾	4	18	3½	7	3
10¼	⅝	2	0.60	5.13	1¼	3¾	3½	12	2½	5¾	2¼
10½	9/16	1⅝	0.44	4.27	¾	3½	2¾	9	1½	5	1¾
10¾	½	1½	0.35	3.48	½	3	2¼	7	1	4½	1½
10 *a*	7/16	1⅜	0.29	3.00	⅜	2¾	2	5½	¾	4¾	1¼
10⅞	⅜	1¼	0.26	2.50	¼	2½	1½	4½	½	3½	1

WIRE ROPES OF 7 WIRES TO THE STRAND

Trade number.	Diameter.	Circumference.	Weight per foot in pounds.	Iron: Breaking strain in tons of 2000 lbs.	Iron: Working load in tons of 2000 lbs.	Iron: Circumference of new Manilla rope of equal strength.	Iron: Minimum diameter of sheave in feet.	Cast Steel: Breaking strain in tons of 2000 lbs.	Cast Steel: Working load in tons of 2000 lbs.	Cast Steel: Circumference of new Manilla rope of equal strength.	Cast Steel: Minimum diameter of sheave in feet.
11	1½	4⅝	3.37	36	9	10	13	62	13	13	8½
12	1⅜	4¼	2.77	30	7½	9	12	52	10	12	8
13	1¼	3¾	2.28	25	6¼	8½	10¾	44	9	11	7¼
14	1⅛	3⅜	1.82	20	5	7½	9½	36	7½	10	6¼
15	1	3	1.50	16	4	6½	8½	30	6	9	5¾
16	⅞	2⅝	1.12	12.3	3	5¾	7½	22	4½	8	5
17	¾	2⅜	0.88	8.8	2¼	4¾	6¾	17	3½	7	4½
18	11/16	2¼	0.70	7.6	2	4½	6	14	3	6	4
19	⅝	1⅞	0.57	5.8	1½	4	5¾	11	2¼	5½	3½
20	9/16	1⅝	0.41	4.1	1	3¼	4½	8	1¾	4¾	3
21	½	1⅜	0.31	2.83	¾	2¾	4	6	1½	4	2½
22	7/16	1¼	0.23	2.13	½	2½	3¼	4½	1¼	3½	2¼
23	⅜	1⅛	0.19	1.65	—	2¼	2¾	4	1	3¼	2
24	5/16	1	0.17	1.38	—	2	2½	3	¾	2¾	1¾
25	9/32	⅞	0.125	1.03	—	1¾	2¼	2	½	2¼	1½

The accompanying tables of rope data are published by the John A. Roebling's Sons Co. With their aid the design of a rope transmission system may be readily made as illustrated herein, although for the usual cases to be met the above company have worked out and published a series of tables giving the horsepower, diameter of rope, diameter of sheaves, and revolutions per minute of sheaves for spans of 100 ft. up to 350 ft.

The Hallidie-Painter Co. of San Francisco, representing Cheschen & Sons Rope Co. of St. Louis, Mo., point out the importance of liberal design in rope transmission, and lay especial stress upon the speed of the rope, their experience and observation having been that nearly every transmission that has proven a failure has been because the speed was too high. Their best results on small sheaves have been obtained by running the rope at 1200 to 1600 ft. per minute. Especial attention should be given the sheaves and their supports; to see that the wheels are set true on the shaft, and are bored true; to see that the shafts are parallel, and that the wheels are exactly in line.

Rope transmission is sometimes used for driving an electric generator from a counter shaft or engine. In this case the span is so short that an artificial tightener must be used. It is also necessary to use several ropes side by side or to use several turns of a continuous rope. The last turn usually feeds onto an idle pulley and hence across the various ropes to the beginning side of the driving sheave. This idle pulley is mounted on a movable frame and to the frame is attached a rope running over a pulley and vertically down to a weight. This weight serves to keep a constant tension on the system of ropes. Great care must be taken in such installations to see that the sheaves are all of the same size, else one section of the rope will be overstrained.

The application of rope transmission is not very general at the present time owing to the presence of electric transmission. It might, however, be considered where the amount of power to be transmitted is small and the distance not great enough to warrant the purchase of a generator and motor in addition to the line. But where electric power is available it is far preferable.

CALCULATION OF STEAM ENGINEERING TESTS.

The Slide Rule.

Probably the most important instrument in all engineering calculations is the slide rule. Its use among engineers has become almost universal, and although the principle upon which its operation is based are those of the so-called higher mathematics, yet these principles are so ingeniously utilized that the slide rule, once understood, is amazingly simple. In taking up this subject with the intention of giving such an explanation of the instruments and apparatus that the non-technical man may readily follow the line of thought, we have purposely prefaced the study of the slide rule with the foregoing statement; in fact, we can assure the reader that although he shall be led into the mysteries of logarithms, algebra, and perhaps even trigonometry, he shall be left safe in his old haunts of the multiplication table, and fraction world, but with an added possession whose usefulness, as well as whose simplicity, will keep it ever afterward in his power.

The slide rule is primarily an instrument for mechanically performing the operations of multiplication, division, involution (the raising of numbers to higher powers as squaring or cubing) and evolution (the extraction of the roots of numbers as square roots, cube roots, etc.). Any one of these four processes may

be done accurately enough for almost all practical purposes, and the probability of error is much less than in the older, laborious methods of calculation. In addition to this exactness, the rapidity with which successive multiplications, for instance, may be performed is remarkable.

The slide rule is based primarily upon logarithms and so we will face them first.

When you see the statement that 100 is the square of 10, or 1000 is the cube of 10, you know that 10 is multiplied by itself once, or, as is said, is squared to equal 100, and is cubed to equal 1000.

Thus $10 \times 10 = 100$, and

$10 \times 10 \times 10 = 1000$.

You have seen these written also $10^2 = 100$ and $10^3 = 1000$; and continuing $10^4 = 10{,}000$, and so on. The little number above and to the right of the 10 in these examples is the **logarithm** of the quantity on the right of the equality sign. Thus, the logarithm of 100 is 2; of 1000 is 3; of 10,000 is 4; and so on indefinitely. (It may be noted that the logarithm is equal numerically to the number of zeros in the number.)

Now, suppose it were required to multiply 100 by 1000. You will see instantly that the answer is 100,000, or it may be written 10^5. If we express this operation as follows, $10^2 \times 10^3 = 10^5$, it will quickly become apparent that the whole operation may be accomplished by simply adding the logarithms, or $2 + 3 = 5$, and placing the logarithm, 5, at the upper right of the 10 for the answer.

We thus have the general rule: to multiply numbers together, add their respective logarithms; the resulting sum is the logarithm of the product of the numbers.

The slide rule is a simple mechanism for adding together the logarithms of numbers.

Conversely now it is evident that to divide one number by another we have but to subtract their respective logarithms, the difference being the logarithm of their quotient. Thus, $10{,}000 - 1000 = 10$, or $10^4 - 10^3 = 10^1$; $4 - 3 = 1$.

Hence a fraction like $\dfrac{100 \times 1000}{10}$ may be solved by saying $2 + 3 - 1 = 4$, or $10^4 = 10{,}000$.

Now ask yourself the question, What is the logarithm of 30? Since the logarithm of 100 is 2, and of 10 is (1), it is evident that the logarithm of 30 will be (1) and some fraction—it is somewhere between (1) and 2.

If we were to plot a curve with the numbers 0, 1, 10, 100, etc., on the horizontal as abscissae, and the logarithms 0, 1, 2, 3, 4, etc., vertically as ordinates, the values of the logarithms might be read off for numbers along the horizontal between 10 and 100, as, for instance, 30.

These values can be computed mathematically, however, and such computations have been made. They constitute the elaborate tables which are to be found in text books on mathematics or surveying.

Thus, the values of the logarithms of numbers between (1) and 10 are:

Log. 1 = 0.00000	Log. 6 = .77815
" 2 = .30103	" 7 = .84510
" 3 = .47712	" 8 = .90309
" 4 = .60206	" 9 = .95424
" 5 = .69897	" 10 = 1.0000

The subdivisions between the above numbers have, of course, been worked out to the smallest fractions, but these values as given will suffice for our present requirements.

We are now ready to lay out our slide rule.

Draw a line 10 inches in length and from the left hand end as 0, mark and letter off the distances in inches corresponding to the first two figures of the logarithms given above. Thus, a = 0. inches, b = 3.0 inches, c = 4.7 inches, d = 6.0 inches, e = 6.9 inches, f = 7.7 inches, g = 8.4 inches, h = 9.0 inches, i = 9.5 inches, j = 10.0 inches.

Our scale will then appear as in Fig. 1. Instead of putting down the actual values of the logarithms, the actual numbers—for which the distances from (a), as logarithms, stand—are used.

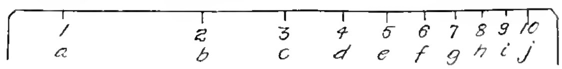


Fig. 1

Now, suppose we wish to find the product of 2×3. It is merely necessary to add the distances (a b) and (a c) along a straight line, and then measure off the sum on the scale from, (a). It will be found to equal a f or to have the value 6.

If another scale exactly like the one we are using had been available, the (a) of this scale could have been placed opposite the (b) of the original scale and then the mark f on the original scale could have been read off directly as opposite to (c) of the second scale as shown in Fig. 2.

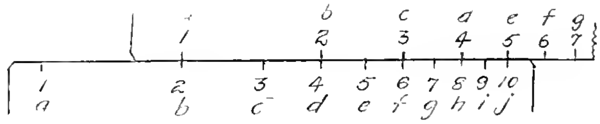


Fig. 2

In this last example we have represented the two essential parts of the Mannheim slide rule. The original scale is the rule proper while the second scale is the slide, these two scales corresponding to the two lower scales of the Mannheim rule.

(To be continued.)

FORMULA FOR TOTAL HEAT OF SATURATED STEAM.

Values of the total heat of saturated steam, as given in the new steam tables of Marks and Davis, agree closely with the following formula derived from the tabular figures by Robert H. Smith: $H = 1826 + t - [1{,}250{,}000 \div (1620 - t)]$, in which H is the total heat above 32° F. in British thermal units, and t is the temperature in Fahrenheit degrees. Between 70° and 500° F. the difference between the figures of the table and those computed by the formula does not exceed 0.9 B. T. U. Between 100° and 450° the difference does not exceed 0.4 B. T. U.

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue*. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Our Steam Department

The steam engineers of the Pacific Coast have long felt the need of a publication in which they could discuss questions of local interest. Some of these problems are so new that none but Western engineers have had the experience to intelligently answer them, and others are so old and have been answered so often that we are likely to forget that the younger men must also learn them. To supply this demand alternate issues of the Journal of Electricity, Power and Gas now contain a power plant department under the caption "Steam."

A glance through our files for the past fifteen years shows that this is no new departure. In our back numbers are to be found many articles on all the various phases of power plant economics written by men that are now at the head of the profession. Our present intention is to replace these occasional papers by a regular series of practical articles.

Foremost among the new subjects to be treated is that of how best to burn the fuel oil with which the West has been so bountifully blessed. Elsewhere in this issue Mr. R. F. Chevalier tells of its source and its physical properties and in future numbers will detail the methods of burning it under boilers. Of the subjects perennially new are of those of the slide rule, the indicator and other instruments for determining steam engine efficiency, which are being simply explained by Mr. J. G. De Remer. Supplementing these are descriptions of new steam installations in both isolated and central stations and timely comment upon new matters that may come up in the great field of steam engineering.

Undamped Waves

As electric transmission of power has proven more efficient for long distances than rope transmission, so is the undamped wave becoming recognized as a better means of transmitting wireless signals than the damped wave. The term "damped" has no reference to moisture, referring only to retarded motion, which, by the way, is sometimes the physical effect of wetness. A damped wave is one whose vibration is quickly lessened or checked, while the undamped variety does not die out so quickly. The same phenomena is seen in a magnetic compass or in an electric meter, in some of which the needle quickly comes to rest, the damped, and in others in which the needle vibrates for some time before becoming stationary, the undamped. This distinction is necessary for a proper understanding of Mr. C. F. Elwell's article on the Poulsen wireless system.

The first methods of producing wireless waves, such as the Marconi, depended upon the agitation produced in the ether by an electric spark. The disturbance gradually decreases in amplitude as it travels from the source, much as do the waves made by dropping a stone in water. On the other hand, the waves made by a vibrating electric arc, such as the Duddell or Poulsen, are continuous, the oscillations being sustained or reinforced by rapid repetition. It is to this peculiar characteristic that are due many of the superior results obtained with this system of wireless telegraphy and telephony as compared to the better-known spark systems.

PERSONALS.

C. A. Coffin, president of the General Electric Company, is in California.

F. B. Gleason, manager of the San Francisco office of the Western Electric Company, left for the East this week.

E. J. Marshall of Los Angeles, who is interested in the Home Telephone Company, arrived in San Francisco during the past week.

John B. Miller, president of the Southern California Edison Company of Los Angeles, is making an automobile tour through Europe.

E. J. Dwyer, manager of the Holabird Electric Company, of Seattle, spent the past week in San Francisco, visiting the Holabird-Reynolds Company.

W. B. Southwick, manager of the United Wireless Telegraph Company office in Seattle, Wash., arrived in San Francisco during the past week.

W. S. Heger, Pacific Coast manager of the Allis-Chalmers Company, has just returned to his San Francisco office, after visiting in Los Angeles.

George E. Hanscom, who is connected with the wireless telegraph service of the United States Navy and has installed a number of wireless plants on the Coast, was a recent San Francisco visitor.

M. C. Miller, assistant to the president of the Allis-Chalmers Company, who has spent the past two months on the Coast, left San Francisco last week for Milwaukee, Wis., and will visit points in Texas en route.

Frank J. Campbell of Denver, who was elected president of the Nevada-California Electric Power Company, was taken ill recent with pneumonia, while preparing to leave for Goldfield, and died within a week.

F. X. Cleary has been appointed advertising manager of the Western Electric Company. Mr. Cleary has been with the Western Electric Company for about twenty years and has held important positions connected with the execution of sales campaigns for the company.

Frank E. Corwin, Pacific Coast manager for the Bryant and Perkins electric companies, has been seriously ill at his home, 1822 San Antonio avenue, Alameda, California, but is now believed to be on the road to rapid recovery. He will take a leave of absence and recuperate in the mountains.

W. P. Hammon, who is at the head of the California-Nevada Power Company and other large electrical enterprises, has returned from a trip to Boston and other Eastern financial centers. Mr. Hammon has been instrumental in bringing at least ten millions of Eastern capital into California for investment in electrical and gold-dredging companies.

Henri Milon, engineer of posts and telegraphs, of France, and Albert Thomas, chief engineer of the French Telephone Company, of Paris, have spent a week in inspecting the telephone systems in San Francisco. They previously visited a number of the large cities of this country on a mission from the French government, in order to study American methods

W. C. Bryant, of the Bryant Electric Company, and E. K. Patton, who is Western manager of the Perkins Electric Switch Company, as well as of the above named corporation, are visiting their San Francisco office. H. E. Sanderson has arrived from Chicago and will take charge of the local office while F. E. Corwin, who has been ill for several months, makes an extensive trip for his health.

Wynn Meredith, Pacific Coast manager for Sanderson & Porter, will leave next week for Victoria, B. C., on business connected with the British Columbia Electric Railway Company's new hydro-electric installation on the Jordan River. During his absence of several weeks Mr. Meredith will visit Aberdeen, Wash., where his firm has purchased the electric railway lighting plant and is planning large extensions.

A JOKER.

The amendments to Articles 21, 25, 37, 39, 42, of the constitution of the A. I. E. E. should be looked over very carefully before marking out the word negative on the ballot, for in doing so you are giving the board of directors the authority to appoint the secretary, on whom we especially of the Pacific Coast so much depend.

Under the present articles you have a voice in choosing the man who you think will best serve the interests of the members, and if the incumbent does not come up to the standard of efficiency you think he should, you at least have a voice in choosing some one who you think will. Mr. Member, you are paying for the band. Do you wish to delegate the choosing of the program to somebody else whose taste may not coinside with yours, by erasing the word negative from the ballot? M. C. LORD.

TRADE NOTES.

The Gould Storage Battery Company report through their San Francisco office that they have contracted to supply a 1000 kw.-hour storage battery equipment to the Oakland, Cal., plant of the Pacific Gas & Electric Company.

On April 1, 1910, the San Francisco office of The Electric Storage Battery Company will be removed from the Crocker building to the offices of Pierson, Roeding & Co., 403-415 Monadnock building. The Exide Battery Depot, under the management of Pierson, Roeding & Co., will continue at 590 Howard street, as heretofore.

The Aberdeen Lumber & Shingle Company, Aberdeen, Wash., is installing electric drive in part of its mill. The necessary machinery has been purchased of Allis-Chalmers Company, and includes one 115 k. w., 480-volt, 3-phase, 60-cycle, 900 r. p. m. belted alternator, one 6½ k. w. 120-volt exciter, two 50 h. p. squirrel-cage induction motors and a switchboard.

The Dean Electric Company announces that after April 1st the San Francisco office will be located at 156 Second street, Jackson Building. In the new location they will have four or five times the space that they now occupy and will have one of the most complete and accessible stock-rooms, with offices, to be found on the Pacific Coast. The steady growth of this branch has crowded them out of their present headquarters and in the future they will have ample space to carry the stock that is necessary for the Pacific Coast territory's needs.

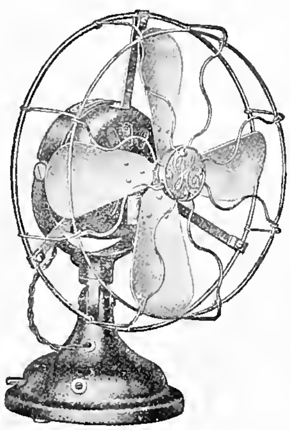
The Pelton Water Wheel Company report that the two double Pelton-Francis turbines being built in their San Francisco shops for the municipal plant at Eugene, Oregon, are nearing completion. Two units comprise this contract, each turbine being of the double spiral, inward flow reaction type Pelton-Francis design. Each runner comprising the unit is separately encased in a spiral housing, but with a central discharge elbow. Under 45 ft. effective head, each turbine develops 1200 h.p. and is direct connected to a 2300-volt, 60-cycle, 3-phase, 360 r.p.m. generator. Two 8-in. diameter wooden stave pipe lines supply water to the turbines, the length of the pipes being about 120 ft. All gate regulating mechanism is situated outside of the turbine casings and a special oil pressure piston type Pelton governor regulates each machine when operating either singly or in parallel. The Pelton governors are equipped with independent oil pumping systems and provided with anti-runaway mechanism, auxiliary and independent hand control. Spiral Pelton-Francis turbines are also being built for pressures up to 120 ft. head; the last one to be built being a 1200 h.p. turbine for this pressure, revolving at 600 r.p.m. The New York works of the Pelton Company also report the sale of several large Pelton-Francis turbine units intended for the power plants now being erected in Minnesota, Vermont and South Carolina.

INDUSTRIAL

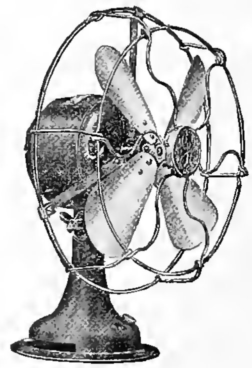
GENERAL ELECTRIC FAN MOTORS.

The 1910 designs of the General Electric fan motors, although substantially the same in external appearance as those of 1909, possess a number of refinements in both the mechanical and electrical designs which contribute greatly to their attractiveness, convenience and reliability. Additions have been made which render this one of the most complete lines of fan motors for a. c. and d. c. circuits on the market. It comprises 8-in. desk, bracket and telephone booth; 12-in. 6-blade residence; 12-in. and 16-in. standard desk and bracket; 12-in. and 16-in. oscillating desk and bracket, and ceiling and column fan motors.

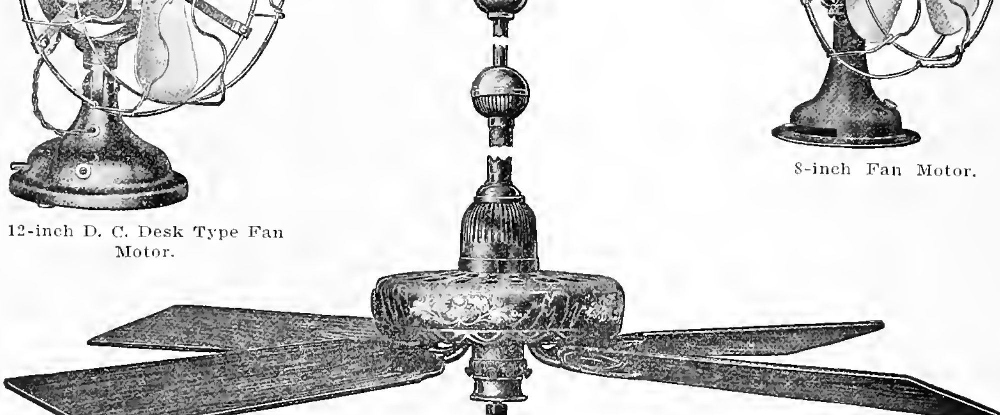
The G. E. 8-in. desk, bracket and telephone booth fan motors have many superior qualities. Since the frame and base are made from drawn brass, the weight is very much reduced and a smooth exterior surface is obtained to which a lustrous black copper oxide finish is applied. The motor is practically noiseless, but a highly efficient air delivery is possible because of the employment of the propeller type of blade. The energy required is less than for an eight candle-power incandescent lamp. It will be found particularly well suited to residence and small office use.



12-inch D. C. Desk Type Fan Motor.



8-inch Fan Motor.



Ornamental Type Ceiling Fan Motor.

Twelve-inch 6-blade residence fan motors are designed for use in residences, hospitals and places where the humming sound produced by 4-blade fans operated at speeds necessary to produce a sufficient circulation of air, is objectionable.

Residence fan motors are only furnished in the 12-in. size and for alternating current circuits. With the exception of being wound for lower speeds and equipped with six blades, the motors are identical with the standard 4-blade type.

General Electric oscillating fan motors have approximately the same general characteristics as desk motors of similar rating. The oscillating mechanism is of the positive type and so designed that it does not interfere with the swivel and trunnion adjustment features, or the change from desk to bracket type and vice versa. The additional power required to operate the oscillating device is very slight, being from 3 to 5 watts. A knob on the spindle permits the oscillating mechanism to be instantly thrown in and out of action while the motor is running. The motors can be installed in any position and will oscillate satisfactorily at any one of the three speeds at which the motor can be operated, whereas wind-operated motors are suitable for desk or shelf use only and will oscillate at high speed only.

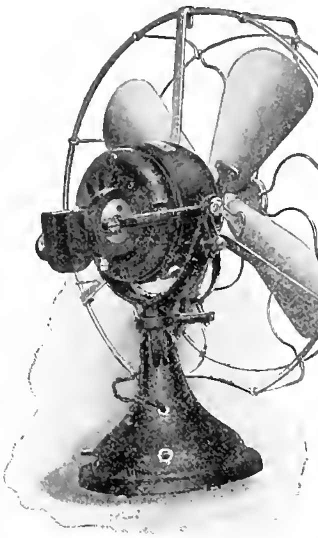
At full speed the motors will make approximately six complete oscillations per minute. This rate is considered to be most efficient and best suited to the general conditions. The speed of oscillation is uniform and positive throughout the entire range.

A marked improvement has been made in the method of adapting the General Electric Company's fan motors for either desk or bracket use. The body is mounted in a yoke hinged to the base, and can be quickly adjusted for either desk or bracket use without the use of any additional parts, it being simply necessary to loosen a screw in the base to allow the vertical adjustment of the motor to either position.

The swivel and trunnion adjustment permits a quick change in either a horizontal or vertical direction to suit the varying heights at which the motors may be placed. The motor body is so pivoted in its yoke that it does not become overbalanced when placed in other than a horizontal position.

In developing the present model a. c. and d. c. ceiling and column fan motors the General Electric Company's aim has been to produce a motor of individual design. While the entire line presents an unusually attractive appearance, the ornamental motors are particularly distinctive. No attempt has been made to employ the conventional embossed thin sheet metal casing to cover up a rough motor. The ornamental features employed are embodied in a finished cast metal frame and are dignified and rich.

Great care has been taken in the refinement of the electrical and mechanical design, and the motors are unexcelled for efficiency, air delivery and freedom from noise. Only a subdued sound produced by the blade cutting through the air



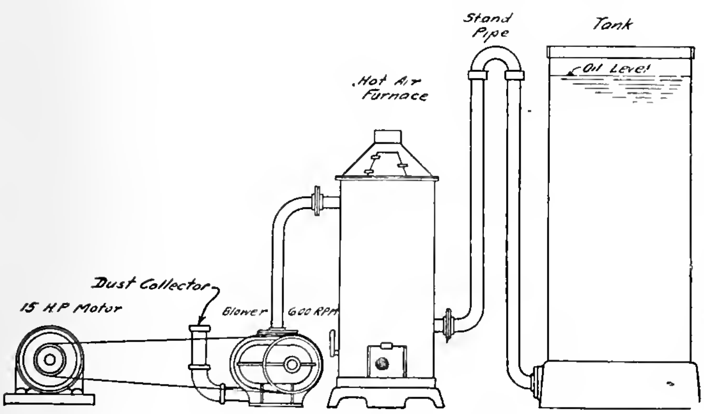
12-inch A. C. Desk Type Oscillating Fan Motor.

can be heard when the motors are running at full speed. General Electric motors are designed for all standard voltages and frequencies.

A NEW OIL AND TRANSFORMER DRYING DEVICE.

Experience has demonstrated that it is practically impossible to prevent moisture from being deposited in transformers during transportation or storage, as condensation takes place on the surface of the oil and metallic surfaces whenever these are cooler than the surrounding air. It is of the utmost importance therefore that adequate means be provided for drying out the transformer and oil.

The device shown diagrammatically in the cut, designed for this purpose, is manufactured by the General Electric Company, and consists of a hot air furnace, positive pressure blower, dust collector, driving motor, and necessary piping, pulleys and belt. Hot air, free from dust, is forced into the transformer through the oil valve in the base of the tank.



New Oil and Tsansformer Drying Device.

The hot air furnace contains a three-inch wrought-iron coil suitably supported inside a sheet iron casing, the whole being mounted on a cast-iron base. The furnace is designed in a manner similar to a self-feeding stove, two doors being provided, one at the top of the furnace for the admission of fuel, and one at the bottom for removing the ashes and also regulating the draft. Wood and charcoal have proved in actual experience to produce very satisfactory results as fuel, but hard coal may also be used if forced draft is provided, which can be easily accomplished by tapping the pipe between the blower and the furnace. Standard three-inch wrought-iron piping is used throughout, but as it is procurable almost anywhere, only the connection between the blower and the furnace is furnished by the manufacturers. If the connections between the furnace and the transformer tank are of appreciable length it is advisable to cover them with heat insulating materials to prevent the loss of heat.

The positive pressure blower has a normal capacity of 300 cubic feet of free air per minute delivered at a pressure of six pounds per square inch, is designed for a speed of 600 revolutions per minute, and requires fifteen horsepower to drive it when delivering normal output.

The dust collector or air filter consists of a perforated sheet metal pipe four and one-half inches in diameter, connected to the blower with a suitable elbow and forms the point of entrance of the air to the blower. Cheese cloth should be tied around the pipe so that the air in entering the blower may pass through it and the dust be retained in its meshes.

Any available power, as a steam engine, gas motor, electric motor, etc., will drive the blower satisfactorily.

The piping between the furnace and oil tank is extended above the oil level to prevent flooding the furnace with oil if the valve in the base of the tank is not closed when the blower is stopped.

The method of its operation is as follows: After the fire has been started in the furnace the fan should be put into operation. The air is drawn through the dust collector which frees it from all impurities and is then heated in the furnace to approximately 100 degrees centigrade. The hot air being forced through the transformer and oil at a pressure of six pounds per square inch, absorbs all the moisture and raises the di-electric strength of both the oil and windings to its original value. No hard and fast rule can be given as to the time actually required for thoroughly drying out the transformer, but it is believed for ordinary cases of moisture, that a ten-hour run after maximum temperature is attained, will be sufficient. Break-down tests should be made from time to time on samples of the oil taken from the transformer and the drying continued until the oil is able to withstand a puncturing test, the value of which is prescribed by the transformer manufacturer.

NEW CATALOGUES.

Chain Belt Company of Milwaukee, Wis., in catalogue No. 39, present illustrations and descriptions of their chain belt concrete mixer.

Smith, Emery & Co., 651 Howard street, San Francisco, have issued a neat pamphlet telling of their facilities for inspecting iron, steel and cement, both in the East and in the West.

The Western Electric Company has ready for distribution Bulletin No. 1110, describing its new types of telephone and signal apparatus for mines. The bulletin takes up the development of the Western Electric mine telephones and describes completely features of construction and operation of its two new types of sets—No. 336-E, a metal set, and No. 337-E, a wood set.

"The Weinland Quick Repair Head" is the title of a little booklet recently published by the Lagonda Manufacturing Company, of Springfield, Ohio. This booklet is devoted mainly to a discussion of the merits of the new Weinland Head, which they have recently brought out, and shows how the head can be quickly taken apart and new sharp cutter wheels installed. This catalogue, which is gotten up in pocket size, also gives a brief description of the various other appliances built by the Lagonda Manufacturing Company.

APPROVED ELECTRICAL DEVICES

CABINETS.

"L. B. E. Co." Steel Cabinets for panelboards, cutouts, and switches. Approved February 9, 1910. Manufactured by

Leonard-Bundy Electric Co., Cleveland, Ohio.

CUTOUT BASES, PLUG FUSE.

"Diamond H." "O. K." Fuse Block Cover. A porcelain cover for Edison plug fuse, branch cutout bases, with steel face plate and seals for preventing use of or tampering with branch circuits by unauthorized persons. Approved Feb. 11, 1910. Formerly manufactured by Price-McKinlock Co. Manufactured by

Hart Manufacturing Company, 103 Allyn St., Hartford, Conn.

FIXTURES.

"Taussig," or "R. & H. Co." Show and Wall Case Reflectors. Cat. Nos. 01, 1, 3 and 4. Metal troughs fitted with approved sockets for candelabra or standard Edison base lamps. Wiring in tubes attached to or channels concealed by reflector bodies. Approved February 9, 1910. Manufactured by

Reflector & Hardware Specialty Mfg. Co., 721 Fulton St., Chicago, Ill.

Standard Electric and Combination Fixtures. Approved Feb. 14, 1910. Manufactured by

Reading Hardware Company, 617 Market St., Philadelphia, Pa.

GROUND CLAMPS.

"Diamond H." "O. K." Ground Clamp. A copper band with lug for soldered connection and screws for tightening. In sizes ½ inch to 3 inches. Approved Feb. 11, 1910. Formerly manufactured by Price-McKinlock Co. Manufactured by

Hart Manufacturing Co., 103 Allyn St., Hartford, Conn.

MISCELLANEOUS.

"Diamond H" Meter Connection Blocks, not over 30 A., 125 V. Special porcelain cutout bases, with metal enclosing case; designed for preventing theft of current and to facilitate the inspection and test of service meters. Type A, with single piece enclosing case. Type E, with two piece enclosing case and with double pole indicating snap switch for use as service entrance switch. The enclosing cases of these devices are not considered as the equivalent of a cabinet for enclosing service entrance switches, when such cabinets are required. Approved Feb. 11, 1910. Formerly manufactured by Price-McKinlock Co. Manufactured by

Hart Manufacturing Co., 103 Allyn St., Hartford, Conn.

Tungsten "Life Saver." Cat. Nos. 5, 8, 11 and 14. A fixture hanger composed of a helically coiled spring arranged between end supports and designed to save the lamps in the fixture from vibration. Enclosed terminal plates at either end of the device afford a means for attaching supply and fixture wires. Approved Feb. 8, 1910. Manufactured by

American Arc Lamp Co., Kalamazoo, Mich.

"Type A" Mercury Arc Rectifiers 125, 250 volts A. C. for 30 or 50 amperes D. C. Type "AA," Automatic and Type "AN" Non-automatic 30 amperes D. C. for general battery charging; and Type "AT" Non-automatic 30 and 50 ampere styles for telephone battery charging. Approved Feb. 9, 1910. Manufactured by

Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Baseplate. This device is a pressed steel base for use on lath and plaster walls and ceilings in mounting surface snap switches, receptacles or other suitable fittings, and with a special fixture plate may be used as a support for electric fixtures. Approved Feb. 9, 1910. Manufactured by

Monroe Electrical Mfg. Co., Monroe, Mich.

RECEPTACLES, STANDARD.

"Bryant." Key and Pull (50 C. P. 250 V.) and Keyless (3 A. 250 V.) Wall Sockets, Brass Shell (slotted or closed bases). Key, Cat. Nos. 9184, 60018, "New Wrinkle" 66609, 68136, 68139, Angle Base 50753, and "New Wrinkle" 68224. Keyless, Cat. Nos. 9185, 50717, 60019, 60020, "New Wrinkle" 66610, 68137, 68140, Angle Base 50755 and "New Wrinkle" 68225. Pull, "New Wrinkle" Cat. Nos. 66611, 68128, 68138, and Angle Base 68236. Also all of the above types with shadeholders attached; key types with composition or insulated metal key. Brass sub-bases, Cat. Nos. 374 and 377, for use with Cat. Nos. 68128, 68139 and 68140. Approved Feb. 11, 1910. Manufactured by

Bryant Electric Company, Bridgeport, Conn.

RECEPTACLES, WEATHERPROOF.

"T. E. M. Co." 3 A. 250 V. Cat. No. 977. Approved for use only when installed where exposed to rainfall, Feb. 7, 1910. Manufactured by

Trumbull Electric Mfg. Co., Plainville, Conn.

SOCKETS, STANDARD.

"Bryant" Brass Shell Sockets. Key, Cat. Nos. 1317, 1318, 9386, 43399, 50760, 99386. "Security Snap," 44147, 44148, 44151, 44914. "New Wrinkle," 59480, 59481, 59484 and 59486. Keyless, Cat. Nos. 1319, 1320, 9392, 43390, 50768, 99392. "Security Snap," 44149, 44150, 44152, 44815. "New Wrinkle," 59482, 59483, 59485 and 59487. Pull, Cat. Nos. 65250-65252 inclusive. Electrolier Sockets for fixture use only. Cat. Noss. 50766, 66237 and Twin Sockets 46750-46752 inclusive. Also above types with shadeholders attached; key types with composition or insulated metal key. Approved Feb. 9, 1910. Manufactured by

Bryant Electric Company, Bridgeport, Conn.

SOCKETS, WEATHERPROOF.

"A. E. G. Co." Pendant Porcelain Socket, Cat. No. 878, 3 A. 250 V. For use in outside festoon wiring, either with or without hanger. Approved Feb. 7, 1910. Manufactured by

Atlantic Electric Goods Co., 3 West 29th St., New York, N. Y.

SWITCHES, AUTOMATIC.

"Diamond H" Remote Control Switches. Type D-2, 25-200 A., 250 V., D. C.; 440 V., A. C. 1, 2, and 3-uole. Types D-3 and D-4, 25 A., 250 V. D. C. or A. C. 2-pole and 3-pole. This device consists of a toggle mechanism operating laminated copper switch blades by means of solenoids. The control circuits to the solenoids to be wired throughout as for low potential systems. Type D-2 is supplied with or without a special iron case. Types D-3 and D-4 are intended for use in wall boxes and are to be mounted directly on the panelboard. Approved Feb. 11, 1910. Formerly manufactured by Price-McKinlock Co. Manufactured by

Hart Manufacturing Co., 103 Allyn St., Hartford, Conn.

SWITCH BOXES.

Cast Iron Switch Boxes for use with flexible tubing. Single, double, three and four-gang, in both shallow and deep types. Approved Feb. 9. 1910. Manufactured by

Graves Switch Box Company, 2190 Stearns Road, S. E. Cleveland, Ohio.

SWITCHES, SURFACE SNAP.

Single Pole and three-way; smaller size 5 A., 125 V.; 3 A., 250 V. Larger size, 10 A., 125 V; 5 A., 250 V. Electrolier and four-point; smaller size 3 A., 125 V.; 1 A. 250 V. Larger size, 5 A., 125 V.; 2 A., 250 V. Double Pole; 5, 10, 20 and 30 A., 250 V. Approved Feb. 9, 1910. Manufactured by

Hart & Hegeman Mfg. Co., 342 Capitol Ave., Hartford, Conn.

NEWS NOTES

FINANCIAL.

BELLINGHAM, WASH.—The City Council has passed an ordinance providing for the issuance of $14,000 worth of water bonds.

TACOMA, WASH.—The Commissioner of Public Works has been authorized and directed to enter into a contract with Bowie & Love for the purchase and delivery of 45,000 pounds of copper wire.

CONDON, ORE.—An amendment to the charter of the City of Condon will be submitted to the legal voters at a coming election to be held April 11, 1910, for the purpose of enabling the city to issue new bonds to the amount of $25,000 for the purpose of completing and repairing the water plant. A new dam must be built at Hay Creek, a new iron pipe to take the place of the old wooden mains and other needed repairs.

INCORPORATIONS.

CASTLE ROCK, WASH.—Home Telephone Company has been incorporated for $3,000, by T. C. Campbell.

LIVINGSTON, MONT.—The State Telephone & Telegraph Company has been incorporated for $500,000 by John Steadman.

ILWACO, WASH.—The North Shore Light & Power Company has been incorporated for $25,000 by F. M. Eidson et al.

NORTH YAKIMA, WASH.—The Englewood Water & Power Company has been incorporated for $1,560, by H. R. Linse et al.

OCEANSIDE, CAL.—The Otay Valley Water Company, with a capital of $25,000. The directors are W. S. and A. E. Broderik and Joe Benesch.

SEATTLE, WASH.—The Behlin Power Company, capital $500,000, has been incorporated by R. C. Burtrand, F. L. Forbes, James H. Henley and W. H. Bruckart.

ELLENSBURG, WASH.—The Ellensburg Oil and Gas Company, with a capital stock of $1,000,000, has been incorporated by J. N. Faust, P. H. Ross and F. Craig.

SEATTLE, WASH.—The Nespelem Falls Power Company has been incorporated, with a capital of $50,000, by James B. Callahan, Wm. Kingsley and John Arthur, New York block.

ROSEBURG, ORE.—Roseburg Oil & Gas Company, principal office Roseburg. The capital stock is $10,000; has been incorporated by F. Dillard, G. Harmon and J. Goodman.

TACOMA, WASH.—The Thomas Gas Light & Power Company has been incorporated, with a capital of $2,000,000, by F. A. Schnable, R. Thomas, W. J. Schmall, A. M. Holton and D. D. Schneider.

PORTLAND, ORE.—Pacific Coast Battery Company, principal place of business Portland, Ore., with a capital of $300,000, has been incorporated by C. Revercomb, A. Sweek and H. W. Darby.

LOS ANGELES, CAL.—Buying and selling of water is the purpose for which the Oil Fields Water Supply Company has been organized at Santa Barbara, with $20,000 capital, by L. C. Man and associates of Santa Maria.

VOLLMER, IDA.—Plans are under way for the organization of the Craig Mountain Light & Power Company, with a capital of $50,000, by W. J. Ramey et al., of this place. The proposed company has a power site on Lawyer's Canyon.

TRANSMISSION.

REPUBLIC, WASH.—The North Washington Power Company has announced its intention of bringing its power line into the Republic camp. The mines, the new mill, the public lighting and power service will be served.

WASHOUGAL, WASH.—The officials of the North Bank Railroad have decided to organize a company to be known as the Clarke County Development Company, with the object of completing the big power plant on the Washougal River.

SACRAMENTO, CAL.—The McGillivray Construction Company was recently awarded the contract for the erection of a sub-station at Eighth and R streets for the Great Western Power Company. The station is to be constructed of reinforced concrete and be two stories high.

MODESTO, CAL.—The LaGrange Water & Power Company has completed wiring and distributing lights in Modesto. Mr. C. H. Noack is superintendent of the Modesto division. It has also completed the wiring of Hughson, in Santa Fe and is preparing to wire Ceres, on the Southern Pacific, south of Modesto. It has installed an additional 400 k. w. generator unit at LaGrange power house.

MERCED, CAL.—The Merced Falls Gas & Electric Company, of which Mr. H. H. Adams is manager, is building a new 1,000 k. w. transformer station at Merced. Is is of concrete and steel, 32 x 52 ft. It is also rebuilding a transmission line between Merced and Merced Falls, eighteen miles, No. 2 bare copper wire, 40-ft. cedar poles, 18 poles to a mile. It is also extending lines from Merced for pumping purposes.

LOS ANGELES, CAL.—When J. Ross Clare, vice-president of the Salt Lake Railroad, authorized the transfer of five acres of land in Long Beach inner harbor to the Edison Electric Company, there no longer remained any doubt as to where the company will erect its $2,000,000 power plant. Work on the mammoth project will start within thirty days. The capacity of the plant will be 100,000 kilowatts, or 13 ,000 horsepower.

OROVILLE, CAL.—Water locations for two new electric power plants have been filed for record here. One was for 1,200 inches of water of the Chico Creek, near Cohassett, by F. E. Mann of that place, who proposes to generate electricity for commercial purposes. The other, for 3,000 inches, by A. E. Smith, president of the Butte-Magalia Consolidated Mining Company, who proposes to generate power on the west branch of the Feather River for the company's use.

TRANSPORTATION.

SNOHOMISH, WASH.—The Seattle-Snohomish Electric Railway Company, represented by C. W. Kimball of Seattle, has applied for a fifty-year franchise for an electric street railway from Seattle to Snohomish.

LOS ANGELES, CAL.—The City Council has decided to either force the Pacific Electric Company to put its single track on Villa street in the middle of that thoroughfare or to lay a double track, called for in its franchise. Los Robles will also undoubtedly be double-tracked.

ASTORIA, ORE.—F. L. Smart, vice-president of the National Public Utilities Company, and Attorney W. L. Chrisman, of the same company, have left Philadelphia for Astoria, where they will close arrangements for the proposed electric road to Seaside, preparations for which were made last November by the company. It is the intention to have the road in operation within a year.

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POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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JOURNAL OF ELECTRICITY
POWER AND GAS
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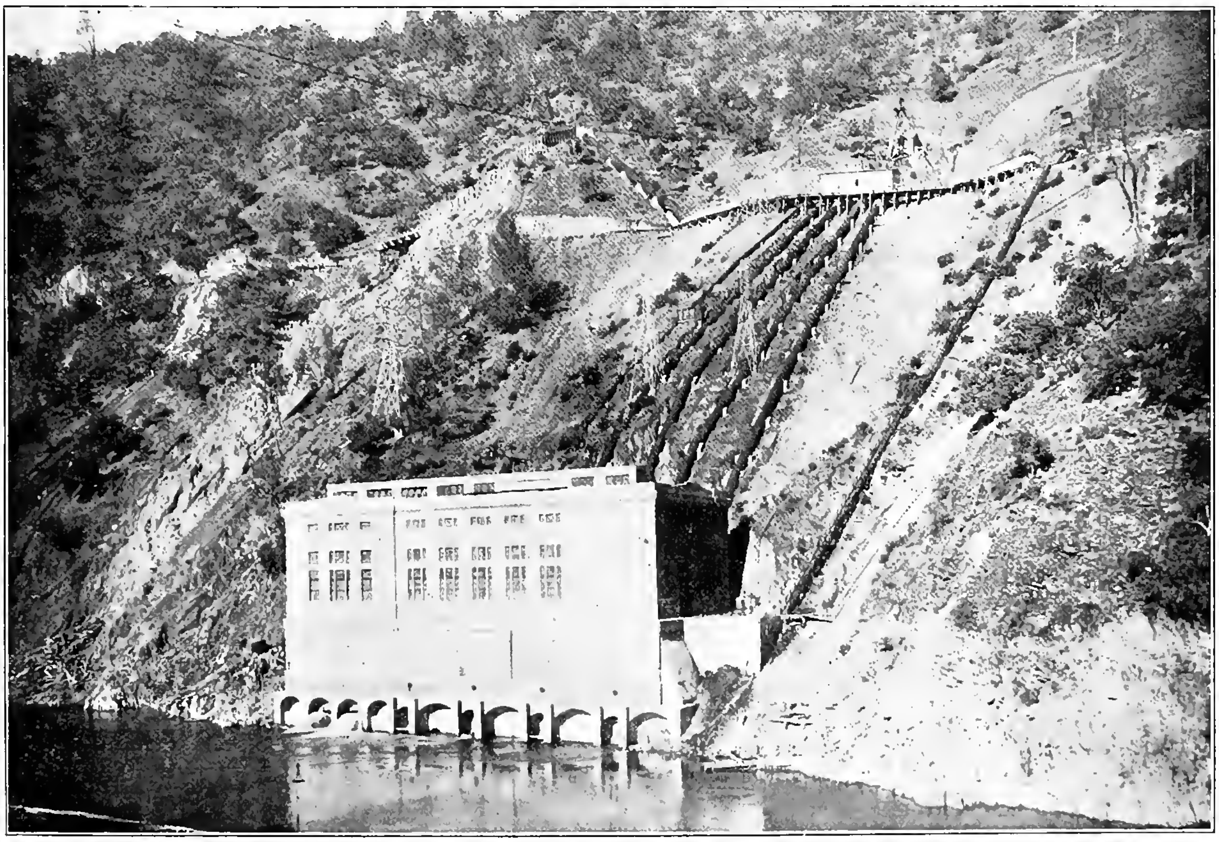
VOLUME XXIV | SAN FRANCISCO, APRIL 9, 1910. | NUMBER 15

GREAT WESTERN POWER COMPANY'S SYSTEM

BY RUDOLPH W. VAN NORDEN[1]

The development of the power system of the Great Western Power Company has been the result of a most daring venture, itself audacious in the originality of its method of extracting from an almost invincible hiding place, a supposed hoard of gold. The story of the Big Bend tunnel, with its hopes and its failures, constitutes one of the chapters in the history of mining in California. The project was too daring, and failed. But the ultimate use of the tunnel and the development of the plant of the Great Western Power Company, add a new chapter, a sequel of final success, not dreamed of by the original promoters, from a utilitarian viewpoint.



Power House, showing Transmission-line Towers, Pipe-lines and Surge-pipe, and Cable Crossing River.

The late Major Frank McLaughlin, who had mined and prospected on the Feather River and adjoining country, realized the value of the river gravel as holding free gold washed down from the upper reaches of the river. He conceived a plan of exposing the bed of the river, around the Big Bend, by carrying the flow, through a tunnel across the bend. Accordingly, he formed a company for this purpose. It was planned to build a tunnel of sufficient size to carry the stream, throughout the period of low

[1] Member A. I. E. E., A. S. C. E.

water flow, which ordinarily lasts from four to five months each year. This would expose about fifteen miles of the stream bed, and it was thought, leave it practically dry, thus permitting of the extraction of gold from the gravel and sand.

The plan met with the approval of Dr. Pierce, a patent medicine manufacturer, of Buffalo, N. Y., who arranged for the necessary funds to carry on the work.

The tunnel was commenced, at its outlet in Dark Canyon, in the fall of 1882. A complete equipment of boilers and compressors was set up at this point, to supply compressed air to operate the drills. An opening 13 ft. wide and 8 ft. high was adopted as being sufficient to carry the flow of the river, and the grade was made 15-16 in. to the rod. Work was prosecuted with all possible haste, in three eight-hour shifts a day, and records as high as 400 ft. per month were made, which, at that time, was considered remarkable.

The project was a gigantic one and called for a constant supply of money. The rock encountered for the first 2,900 ft. was a homogeneous blue slate, fairly hard; beyond this a section of very hard rock was met, which, for a time, arrested progress. The big Burleigh drills could make but little headway and struck fire constantly. It sometimes took 22 hours to drill a round of holes while 13 men were worked on a shift. So difficult was this work, says Mr. Henry Turner, who was a trusted employee and had worked on the project from its inception, and who is still on the ground in the employ of the power company, that on one shift he took out 375 dulled drill-points.

It was at this point that it looked as if the project would have to be abandoned, but a lucky find of gold, while prospecting in a crevice, rich almost beyond belief, bolstered the waning enthusiasm and supplied new life and inspiration for the work.

Water was finally turned through the tunnel on July 4th, 1886, only to disclose the fact that the bore was not large enough to carry the flow, thereby permitting the working of the river bed. A crib dam was also completed, several hundred feet below the mouth of the tunnel during that summer, but in the fall of the same year it was decided to enlarge the tunnel.

This latter work was completed in one year and consisted in removing four feet from the roof of the tunnel, leaving the opening 13 x 12 ft. The work had cost about $750,000. The length of the tunnel was 12,007 ft., or nearly two and one-half miles.

The interesting and objective part of the project was now ready for exploitation; gold so well hidden was to be recovered. During the fall of 1886 the river had been prospected to some extent, but during the summer of 1887, five claims were opened up. These were worked during the summer of 1888 with varying success, but in the summer of 1889 but one claim seemed to hold forth any promise and was alone operated.

Many rich pockets were opened, but it seemed as if fate plotted with Nature against this plucky band of miners. A rich crevice invariably ended with a sharp shelving of the bedrock. It was possible to operate the claims but six months each year and a common error seems to have been made, that of working ground in which, old miners said they had found gold (and as was afterwards proven, had taken all that was there), instead of prospecting untried ground. A claim at Arnum Bar paid one-half ounce per day per man and another above Stone House paid a like amount. But they were of short duration. The claim worked during the season of 1889 at Huff's Bar paid $8 per man per day for the entire season. In fact, the story is told that on the last day of that season, when the river had been rising and the miners were in imminent danger, as the flume was expected to go out at any minute, there were three men working against time, as every moment of work meant more gold. They knew it was their last chance for six months, and during that day took out $950. Finally the rising flood carried away the flumes and sluices and the miners barely escaped with their lives.

So far the value of the gold recovered had been insignificant in comparison with the cost of the project, and from 1889 to 1906 practically nothing was done aside from occasional attempts to prospect the channel. In the latter year, however, the property was leased to some Chinamen, for a term of five years. The crib dam had been destroyed by high water some three years previous to this time and the Chinese lessees undertook to replace it. By the following year they were in debt to the amount of $2,200 and the dam was incomplete, but by persistence they managed to finish the dam in 1898 at a total cost of $3,200. During this season the Chinese cleaned up a total of $5,020 which represented the entire reward of their efforts.

The conception of the utilization of the power in the water flowing down Dark Canyon was not particularly new, for during the intermittent attempts to mine the river some power was derived from a small plant consisting of two 80 h. p. dynamos driven by water wheels. This plant was near the junction of Dark Canyon and the west branch of the Feather River. The flow after leaving the tunnel was carried along the side hill in a canal to a point directly above this plant. Power was brought to the placer claims and used principally to drive pumps.

The project had amounted to a series of failures, insofar as the ultimate object was concerned, but the subsequent sale of the tunnel and properties to a company, now the Great Western Power Company, and the completion of the power plant, on a scale that surpasses anything of the sort in the western part of the United States, has turned the first unsuccessful attempt to extract from Nature her wealth to a glorious victory.

General Plan of Power Development.

The canyon of the Feather River is similar to that of most of the other rivers having their rise in the Sierra Nevada Mountains and flowing into the great central valley of California. The Feather is one of the largest of these rivers, however, and has probably the greatest minimum or low-water flow. It has several branches, the principal ones being the Middle and the North Forks. The source of the former is largely in Sierra Valley, Sierra County, while that of the latter covers all of the upper half of Plumas County. The watershed of all branches is in

California. The largest branch of the North Fork has its rise on the eastern slopes of Mount Lassen and the adjoining country known as the Big Meadows. It is here that the company have large land holdings and eventually intends to construct an enormous reservoir which will supply enough water, during the period of low-water flow, to double the amount of that flow in the river.

During the winter and spring months all of the branches discharge a large quantity of water, but throughout the period of low water the North Fork maintains the highest minimum flow. The low-water record for this branch is said to be about 925 second feet, while it is estimated that the flood discharge is as great as 125,000 second feet.

The problem of a power development would have been similar to many others in the West, were it not for two local conditions, both of which make this installation unique. There was, first, the Big Bend, where the river, turning abruptly at right angles, leaves its general direction and runs in this manner for about four miles and then, by a series of more or less abrupt turns, again recovers and continues the general direction. From the beginning of the bend to its final correction is about twelve miles, but the distance directly across is but three. The fall of the river, per mile, is not great, averaging 35 ft., but the total fall across the bend is 420 ft.

The second condition was the tunnel which had a total fall of nearly 70 ft. The simplest solution of the power problem, would have been to utilize the old canal from the outlet of the tunnel and either the site of the old power plant, or one nearby, for the new installation. By doing this the hydraulic head on the plant would have been determined by the elevation of the canal; the benefit of the fall in the tunnel would have been lost as would also any head due to the reservoir possibility at the intake. Further than this, a variation from low to high water in the river meant an additional sacrifice of power. The problem was, therefore, resolved to the use of the tunnel under pressure, which immediately led to the possibility of a considerable reservoir at the intake, by the construction of a high over-flow dam. Other water rights and properties further up the river were procured, for future development, and with this in view the possibility of increasing the minimum flow during the summer and fall months was apparent. The plant was therefore designed to use about double the minimum flow, to operate a reservoir formed by means of a high dam, which would act as a balancing reservoir and thereby carry peak loads beyond the possibility of the calculated flow, to supply water for, and to operate the tunnel as a part of the pressure conduit.

In order to obviate a long header pipe and at the same time place the plant in the main river, it was necessary to drive an extension to the old tunnel. It was further deemed advisable to enlarge the old tunnel and place a smooth concrete lining through this and the new section; this work to be carried on simultaneously with the construction of the powerhouse.

This design necessitated a high class of modern engineering, and especially so in view of the fact that it was necessary to get the plant in operation in a space of time, much shorter than it would be possible to complete the high altitude storage system and the dam at the intake. To meet these conditions it was necessary to complete the first installation, except in those parts in which interruption to operation could not be considered, to one-half of the ultimate capacity.

Preliminary Work.

Preliminary work by the engineers was commenced in the fall of 1906 and six months later actual construction was in progress. At that time there was no railroad transportation nearer than Oroville, twenty miles away, and the roads were rough and unsuited for hauling heavy materials. It was, therefore, necessary to build or rebuild about twenty miles of road to fit it for heavy hauling. There were no towns nearby, so that the company was obliged to make provision for housing the thousand or more men who were to be employed on the work. Three camps were built, one at Island Bar, a half mile from the powerhouse on the river, one in Dark Canyon at the outlet of the tunnel and one on the mountainside above the inlet. There were a number of smaller camps scattered along the work and the company maintained a well-equipped hospital.

Two sawmills were erected and placed in operation. There were two well-equipped steam-driven compressor plants installed, one at either end of the old tunnel, as well as two complete rock-crushing plants, similarly placed. With this preliminary equipment the work of construction progressed rapidly. Electric power for the crusher plants, the locomotives in the tunnel, lighting, etc., was supplied from these plants and some current was purchased, in addition to that generated, from the Oro Light & Power Company, whose plant is a few miles distant.

At the mouth of the tunnel a cofferdam was built to permit the construction of the intake tower and at the site of the powerhouse a similar device was employed for setting the foundation. A low timber crib dam was built several hundred feet below the intake. This was necessary in order to give the flow the proper diversion into the intake tower and to suffice until such time as the proposed dam could be built.

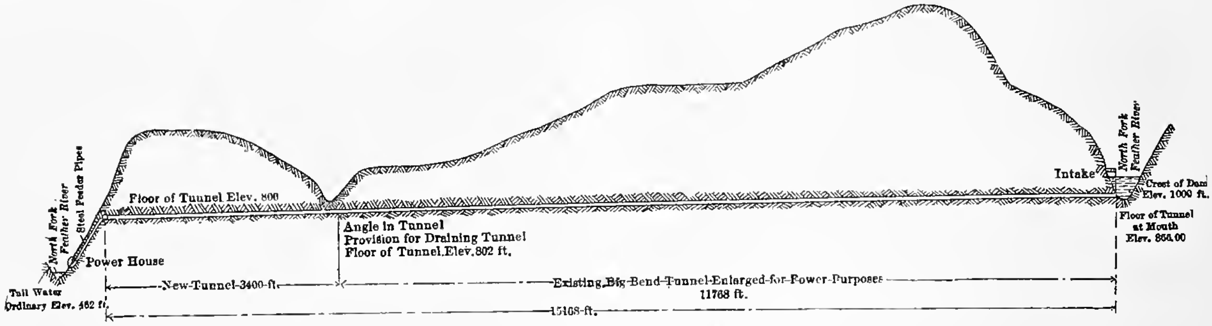
Work on the tunnel and header pipe was completed, as these parts, once placed in operation, could suffer no interruption.

The completion of the Western Pacific track to a point opposite the powerhouse, in 1908, facilitated the delivery of machinery. Cars were shunted at this point and all machinery and supplies were transported across the river, to the powerhouse, by means of two Lidgerwood aerial tramways.

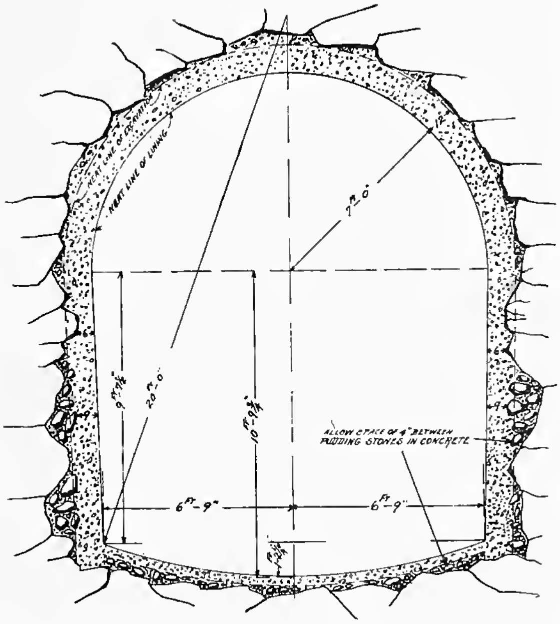
The one designed to carry machinery has a capacity of 35 tons. The cableway consists of two 2¼ in. steel cables, supported from substantial structural steel towers 1,200 ft. apart. It is operated by compressed air and is of sufficient elevation to carry loads to the level of the header pipe. A second smaller tramway was installed to carry light loads, supplies, etc.

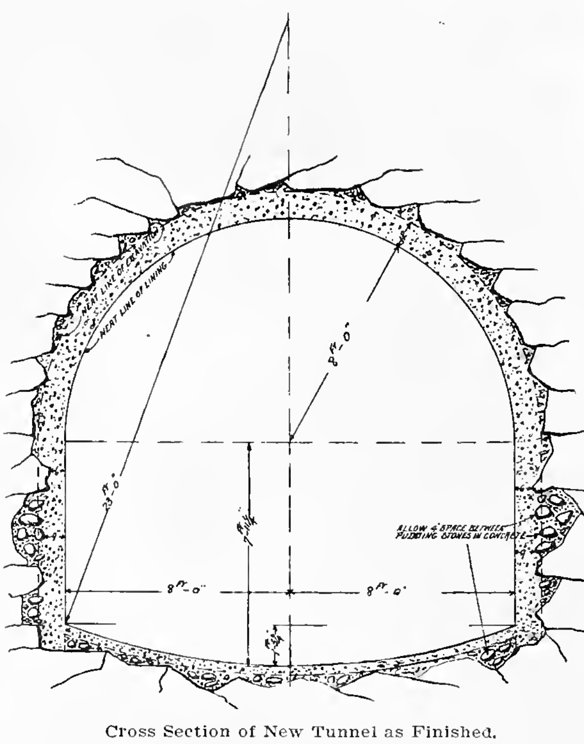
The Tunnel.

The work of enlarging the old tunnel was carried on simultaneously with the driving of the new section. It consisted of widening and giving the roof a semi-circular cross-section. The concrete lining is



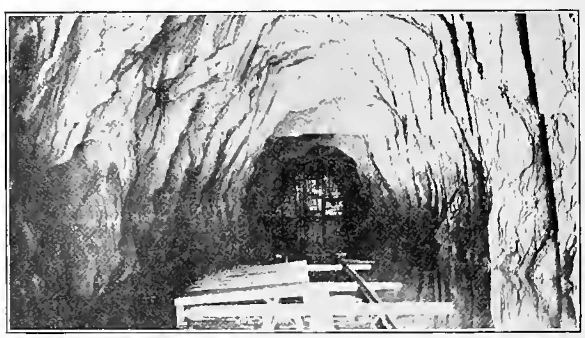
Cross Section through Big Bend Mountain.


Cross Section of Old Tunnel as Finished.


Cross Section of New Tunnel as Finished.

21 in. thick, although this of course varies. The rock formation is hard and very little timbering was necessary. All but 400 ft. of the tunnel was finished in this manner, making the length of the section 11,460 ft.

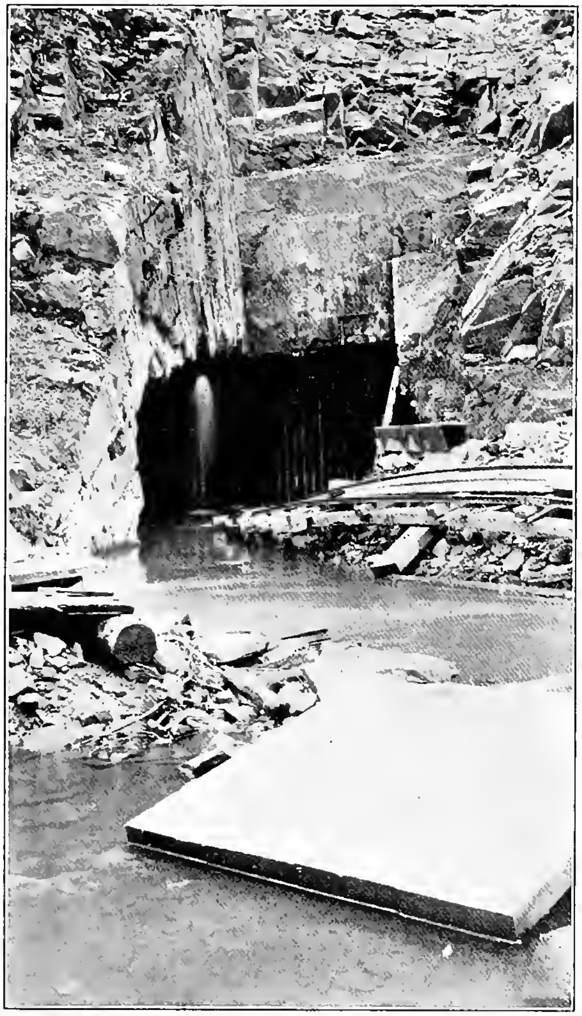
Work on the new section of the tunnel was rapid, due to modern improved methods. At a point 400 ft. within the outlet of the old tunnel, the new section was commenced, its direction bearing away from the former at an angle of 38°. While the grade of the original tunnel, which is 0.5 per cent, could not be changed, that of the extension was made 1 ft. in 3,000. The dimensions are somewhat greater, but the cross-section has the same general form as the older section. The carrying capacity is estimated to be 2,500 cubic feet per second, and the loss in head, at this flow, is 10 ft. The new section has a length of 3,450 ft., and the net area of cross-section is 225 square ft.


Unfinished End of Old Tunnel, showing Bulk-head.

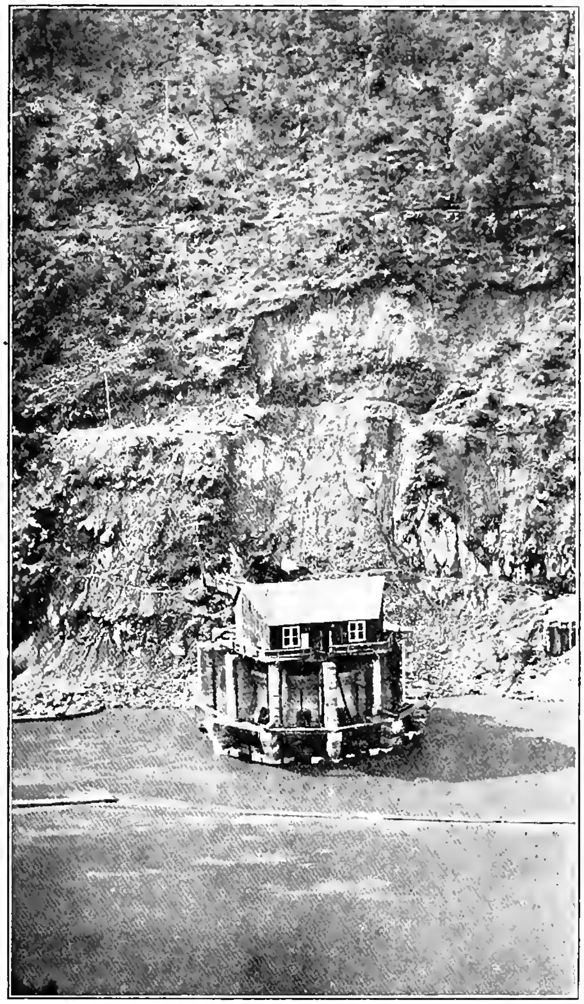
Two concrete bulkheads were erected to plug the unused end of the original tunnel. The first of these is directly at the junction with the new section and is given a curved surface, making a smooth turn from the old to the new sections. Through this bulkhead are a number of small pipes, allowing water to pass to the other side, thus relieving it of pressure. Beyond the first bulkhead is a second. This is 25 ft. thick and is the true plug. Through this, two 12-in. steel pipes, each equipped with two gate-valves, were inserted. These are for drainage, should the necessity arise. The accompanying view shows the section of the old tunnel, between the plug and the outlet. This section has not been altered. The plug can be distinctly seen.

Intake.

Operating the tunnel under pressure, with the ultimate surface of the river 140 ft. above the mouth of the tunnel, necessitated an unusual construction

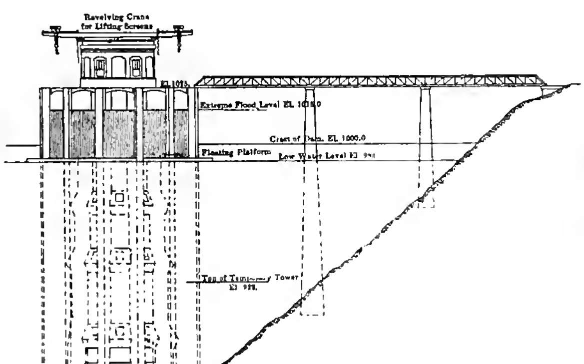


Outlet of Old Tunnel in Dark Canyon.



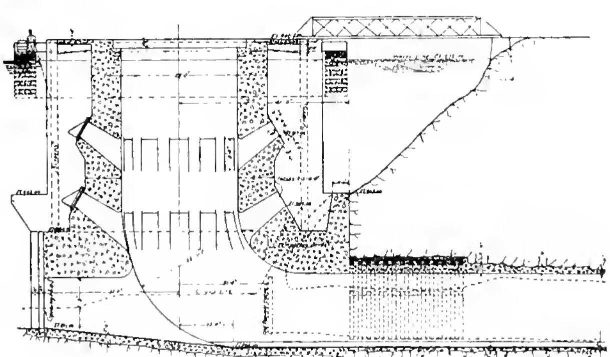
Intake Tower at the Present Time, showing the Four Temporary Sluice Gates.

for the control of the intake flow. Combined with this fact was the advisability of taking water as near its surface as may be possible, to eliminate sand, which



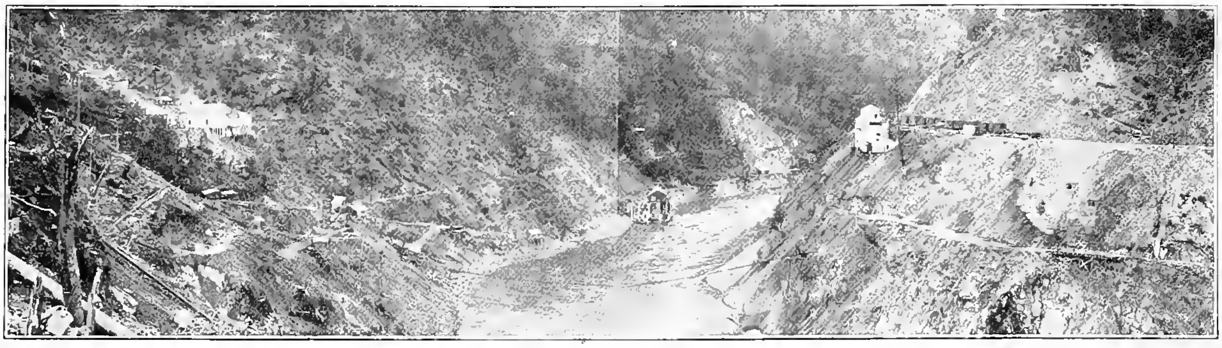
Elevation of Intake Tower as it will Appear when Completed.

will settle to the bottom. A concrete tower has been constructed, which will eventually have four rows of twelve openings each, and each opening controlled by a heavy cast-iron hinged door. The openings are 3 ft. 4 in. by 4 ft. For the present this tower, which has a diameter of 70 ft., has a height of 64 ft. It is proposed to carry it to an ultimate height of 154 ft., and this work will be carried forward in conjunction with the high dam, on which work is about to commence.



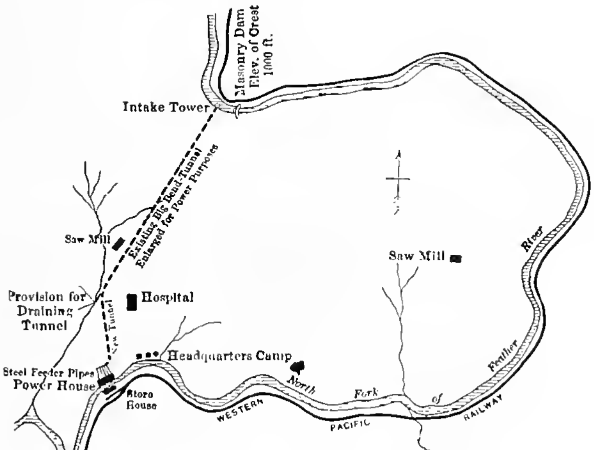
Cross Section of the Intake Tower as at Present Installed.

Under the present conditions of operation, water is taken into the intake tower, through four rectangular sluice-gates 5 ft. wide and 12 ft. 3 in. long. These



Looking up Feather River from a point on the South Bank near the End of the Proposed Dam. Western Pacific Depot; Machine and Forge Shop on the Right; Intake Tower in the Background; Cookhouse and Compressor-House on the Left.

were specially designed and incorporated for the present use and will be abandoned as a method of intake after operation at the full head is possible. They are made up of horizontal sections of timber, 12 x 12 in., fastened together by two vertical bolts extending through the timbers, and the whole raised and lowered by a steel screw operated by a nut and worm gear. The gates slide in grooves in the concrete and are provided with trash screens covering the openings. On top of the tower is a gatehouse, provided with electric motors for operating the gates through worm gears. An ingenious apparatus is also provided for cleaning the trash screens, also operated by a motor. The intake tower, insofar as it is at present completed, is a splendid example of concrete work, both in design and finish.



Map showing Plan of Power Development.

The tunnel and header pipe are complete. A low crib dam at the present time diverts the flow through the intake into the tunnel; the plant is therefore operating under a temporarily low head of 430 ft., although the finished work is all designed for the full head of 535 ft., which will be maintained upon the completion of the high intake dam.

Preparation for Building Dam.

Early in 1910 preparations were commenced for the work on the permanent dam. This is going to be a big undertaking, as, in fact, is every feature of this installation. From the standpoint of the civil engineer, it is one of the most interesting projects at present under construction. There is nothing unusual in the construction of a gravity section wier dam, as many such dams have been successfully built. But this dam will have the distinction of being the highest dam of this type in existence. It will, furthermore, due to its comparatively short crest, have to carry, at times, more water per foot of length than most high overflow dams.

Preparations now being made under the able direction of Mr. W. S. Cone, superintendent of construction, are on a scale of magnitude and completeness well calculated to provide every advantage that engineering skill can suggest, to expedite the work and at the same time carry on the construction in the most economical manner.

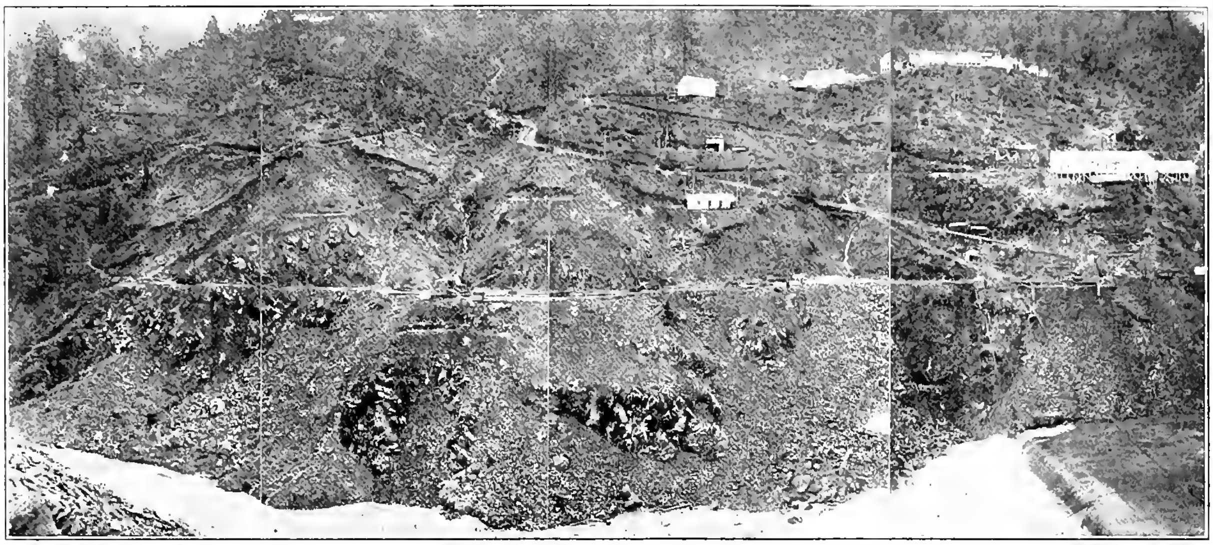
The buildings necessary to comfortably house the workmen and field engineers, also for machinery and materials, have been completed. There are three well constructed camps; one for workmen, one for hostlers and one for the engineers or others in authority. There is a well-equipped hospital with physician and nurse, all situated on the south side of the river.

The Western Pacific Railway occupies the north side and has here a station. Here also is the large storehouse of the commissary department, a well-equipped blacksmith shop and a machine shop. On the south side is a compressor house, which contains two Ingersoll-Rand compressors, each driven by a 150 h. p. induction motor. From this point compressed air will be supplied wherever needed on the work.

Electric current is distributed at 2200 volts, 3-phase, for lighting and power, from a transformer station. This is connected with the powerhouse by a substantial 3-phase 11,000-volt transmission line.

Communication across the river is maintained by four cableways and one suspension foot-bridge. One of the cableways, running to the storehouse, is used entirely by the commissary department. Another is to be used in the completion of the intake tower, and the third and fourth will be used in the construction of the dam. For some time the cableways were the only means of crossing the river and the first trip which an outsider makes in the "skip" is an exciting experience.

The suspension bridge is a structure of interest. The slender, graceful curve calls forth admiration—



South Bank of the Feather River at the Intake. Crib-dam in the Right Foreground; Compressor-house and Cook-house on the Right; Stables and Camp in the Right Background; Transformer-house in Center Background; South End of Proposed High Dam in Center Foreground; Quarry in the Left Foreground; Keystone Drill in the Left of Picture.

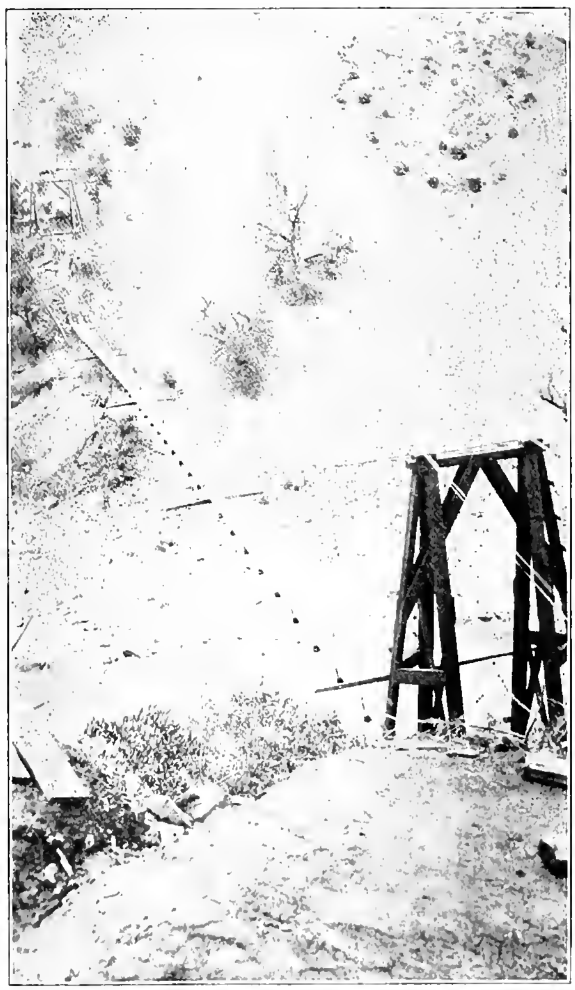
from a distance. But the bridge is well built and perfectly safe, and what is more, a very interesting bit of engineering. It was built entirely out of old discarded steel cables, is 435 ft. long and is supported from two groups, each of three ¾-in. cables. The bracing and connecting ropes are ⅜-in. steel cables. The floor is 2 ft. wide and one is prevented from stepping off sideways by Elwood wire fencing. There are three transverse spars or separators, spaced equal distance apart, that carry at their extremities the cross-bracing to steady and prevent twisting of the footway. The towers are of timber, the one at the south end is 30 ft. high and the one at the north end 22 ft. high, but so placed that its top is 50 ft. above the bridge floor.

The main cables, ending in rods and slings, are carried to anchorages consisting of old rails. A short tunnel was first driven into the bedrock and then from the inner extremity two opposite lateral tunnels were driven. The rails were placed in the latter so that the slings, entering through the main opening, pass about the rails at their middle point There were also iron plates placed vertically at the ends of the rails, and the whole was concreted into a solid mass. The cables have a factor of safety of 7 with a load of 35 lbs. per running foot.

A quarry is being opened on the south bank, a short distance below the end of the crest of the new dam. Work here is being done both with Burleigh drills and a Keystone oil well rig. A complete crusher equipment is to be set up at this point.

The final design of the dam has not been altogether determined, as it is first desired to expose the bedrock thoroughly. The country rock is slate and phylitis (metamorphosed slate, Calaveras series), but the dam will have a foundation of greenstone, which is an altered form of diorite, an intrusive igneous rock.

In general, the dam will have a gravity ogee section, that is, a section such that it will resist sliding or overturning from the water pressure, by virtue of its own weight, the up-stream side being nearly vertical, the crest curved to conform somewhat to the



Suspension-foot-bridge below Dam-site to Administration Quarters.

natural curve taken by the water flowing over it, and the downstream side of the dam, curving in the opposite direction, eventually discharges the water horizontally. It is proposed, however, to give added stability by curving the structure upstream, using a radius about equal to the length of the crest, which will be 500 ft.

During periods of extreme high water the discharge over the crest will be heavy. To lessen the depth of this discharge and also to dissipate, in a measure, the enormous energy of this waterfall, thus

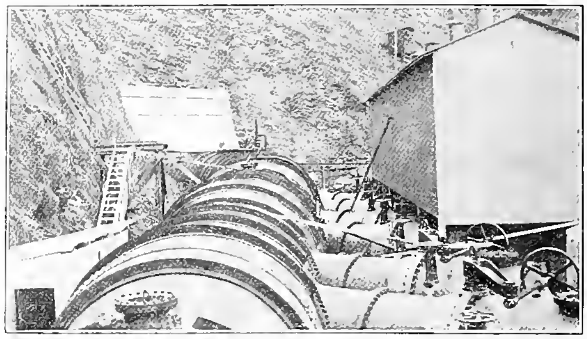
North End Site of Proposed High Dam. The Crest will Reach to a Point about half-way between the Railroad-track and the Road on which the Dump-carts can be Seen. A Test-hole can be Seen in the Upper-right Side of the Picture.

preventing vibration throughout the structure, it is proposed to construct aprons, each 100 ft. long, extending from the ends of the dam downstream, which will act as continuations of the crest and carry part of the flow.

The dam will have a total height of 140 ft. It will contain about 120,000 cubic yards of concrete and will require almost two years to complete.

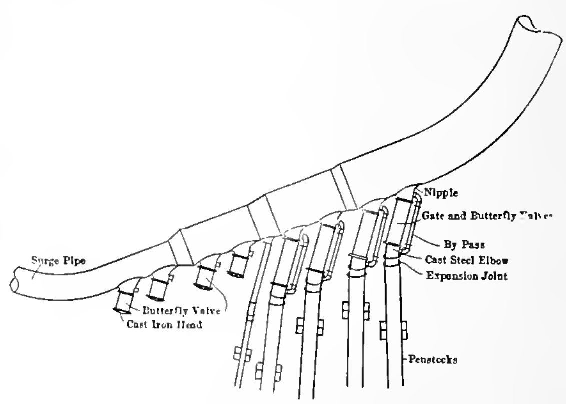
Header and Pressure Pipes.

Imbedded in the concrete walls of the tunnel, and extending into it from the outlet for a distance of 120 ft., the header carries the flow from the tunnel and distributes it to the pipe lines. Starting with an inside diameter of 16 ft. 9 in. and thickness of 1 in. it makes a turn of 46°-30′ just after leaving the tunnel, until it lies parallel to the contour of the mountainside. It is carried on concrete piers which in turn are supported by a solid bed of concrete placed in a bench, cut to the bedrock.



Header-pipe and Tunnel Bulk-head, showing where the Former Enters the Latter.

The header has three tapered reductions in size, giving sections of 14 ft. 11 in., 12 ft. 6 in. and 9 ft. inside diameter. In each of these sections there are two outlets, and each outlet is to supply a pipe line. Four of these outlets are completed and connected to their corresponding pipe lines. The remaining four are each capped with a cast-iron head and are to be used to connect to the pipes of the future installation, when the plant, as originally designed, is completed.



Plan of Header-pipe.

Each branch consists of a cast-steel section, riveted to the header at an angle of 36° and contains a butterfly valve operated by a screw and nut through a bell-crank fastened to the shaft of the valve, a manhole and outlet for a by-pass pipe. To the end of this section and directly in front of the butterfly valve is a cast-steel gate-valve. This is operated by a 15 h. p. d. c. motor, and is controlled from the switchboard in the powerhouse.

A 16-in. by-pass pipe is provided. It is equipped with two 16″ gate-valves, set in tandem, one being manually operated, while the other is operated by a 1 h. p. d. c. motor and controlled from the powerhouse.

To an outlet at a point midway between the fourth and fifth pipe outlets, is connected the 24-in. valves and pipe line which supplies the exciters in the

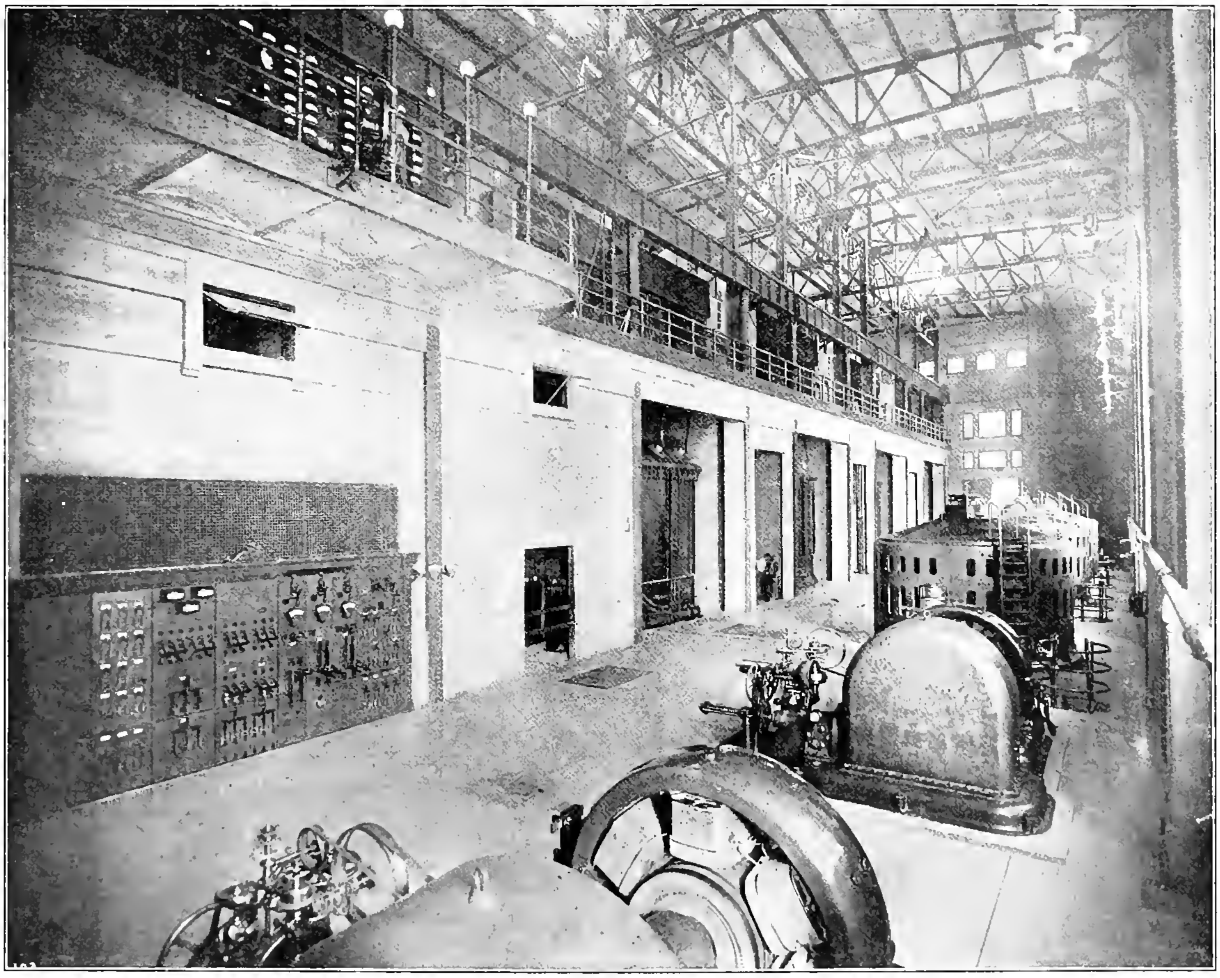
powerhouse. A steel frame corrugated iron shed covers the four motor-operated gate valves, providing protection for the motors and operating mechanism. The header is supplied with three air-valves and four manholes.

After passing the eighth pipe line outlet, the header, without further reduction in size, makes a turn in toward the mountain, this turn being imbedded in a heavy block of concrete, and then turns again following the slant of the hill, until an altitude is reached 22 ft. above the water level at the intake. This is to provide for the liberation of surges which might occur, due to sudden changes in velocity of flow. A concrete chamber is provided at the end of this surge pipe to deflect the overflow into a chute-flume, which carries it down the mountainside to a point where it can cause no damage.

Placed near the header is a building containing an air compressor, belted to an 85 h.p. induction motor. This supplies compressed air for operating the cableway to the opposite bank of the river and also a small cable railroad, which runs between the power-house and the header.

The pipe-lines, like the gate and butterfly valves, are 5 ft. inside diameter. They are sheet steel, welded on the longitudinal seam, and vary in thickness from 13/32 in. at the top to 43/64 in. at the lower end.

One noticeable feature, not in accordance with Western American practice, is the method of connecting the sections of pipe together. Instead of having an inside course, slipped into an outside course, all sections are the same diameter. One end of the section is expanded so as to form a V-shaped ferrule, the other end is expanded to fit the first. The rivets are placed in the ordinary manner, but the groove on the inside made by the ferrule prevents the projection of the rivet heads, and thereby improves the friction factor. The sections are 10 ft. 7 in. long. The sheet steel and the pipes were made in Germany and the header was made in Philadelphia, the latter was riveted together on the ground. The pipe-lines are supported at intervals by concrete carried well down into the bedrock. The average length is 700 ft.

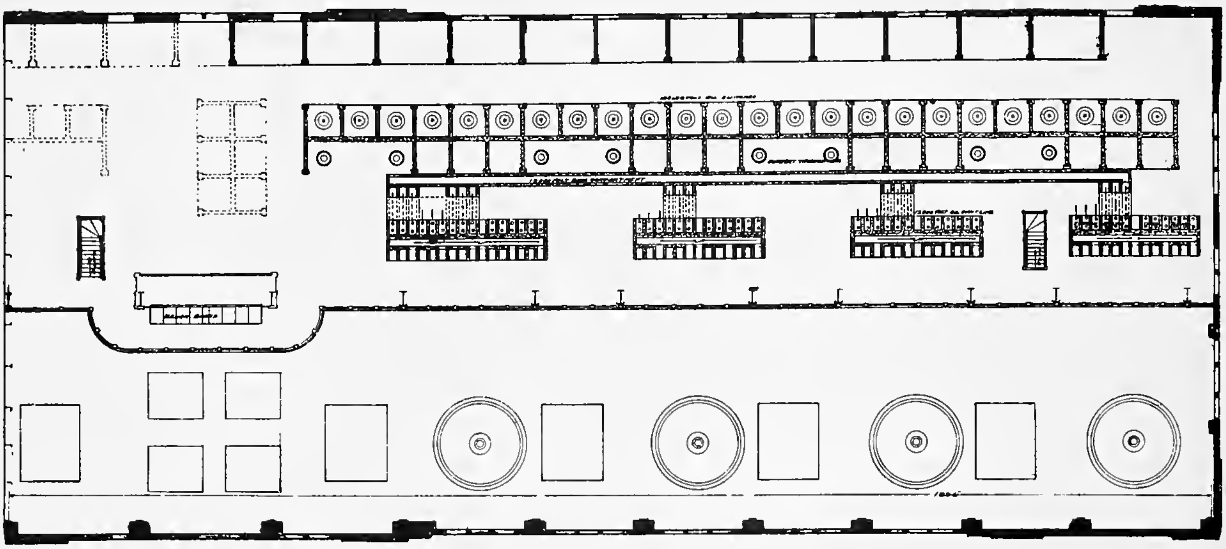


General View in Main Bay of the Powerhouse.

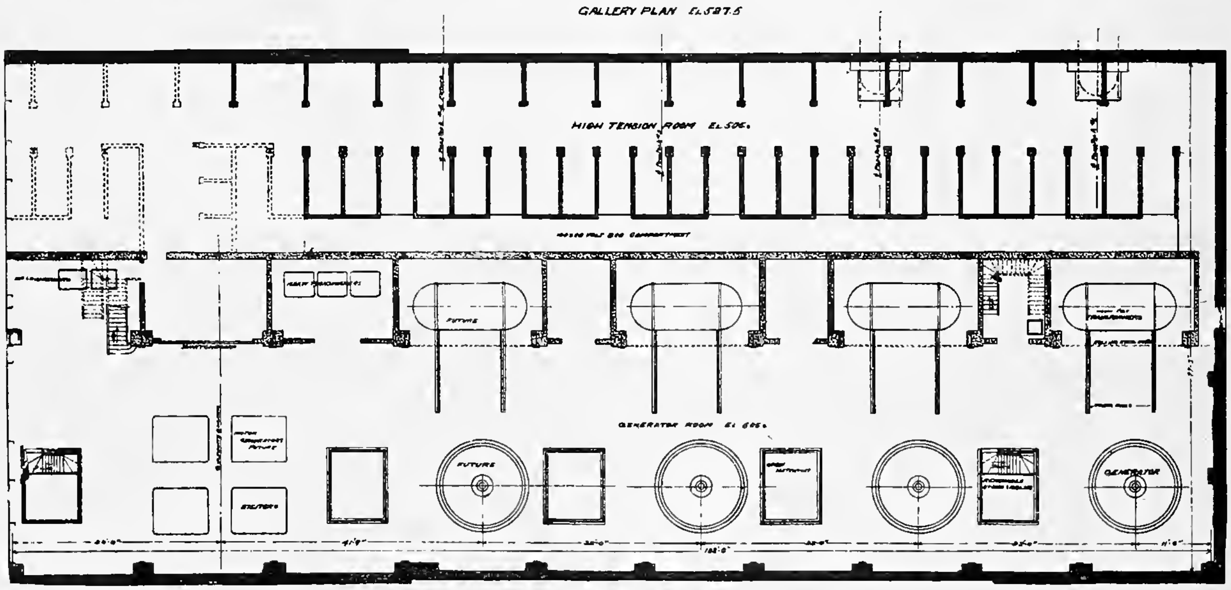
The Power-House.

The site where the power-house stands was originally a steep mountainside, but was selected as it offered a good solid rock foundation. A coffer-dam was erected, extending into the river to facilitate excavation, which was carried down until all possibility of any broken surface rock would be eliminated. The building is 183 ft. 4 in. long and 71 ft. 6 in. wide.

The foundations are of solid concrete under the heavy machinery, but the rear of the building is sup-



GALLERY PLAN EL. 587.5



MAIN FLOOR PLAN EL.

ported on concrete columns and arches, the whole constituting a piece of work calculated to stand for all time. The heavy concrete work is carried up to the main floor. The structure below the main floor is divided longitudinally by a heavy supporting wall and the front also consists of such a wall. The penstocks and main water-wheels are carried directly on the concrete foundation, the draft-tubes passing down through it and discharging below the front wall. The step-bearings and auxiliaries are carried on an arch floor, which is supported between the front and longitudinal walls, and by transverse walls, while the generators which are on the main floor are also carried on arches similarly supported.

The building above the main floor has a steel frame with reinforced concrete walls, which support a steel truss reinforced concrete slab roof. It is divided into two longitudinal bays by a series of steel columns. A 50-ton, electrically-operated traveling crane for handling the generating machinery runs on I-beams supported by the front wall and the center columns, through the length of the front bay. The rear bay is divided into two floors and these are divided up by the various transformer and switching compartments. A mezzanine floor at the west end of the building, between the main and second floors, provides space for storerooms and lavatories. The latter are noticeably complete with every modern convenience, even to a commodious shower-bath.

On the main floor, and directly opposite its generator, in this bay are the transformer compartments, containing the main step-up transformers. Between each of these compartments, of which there are four, are compartments which are put to various uses. In one of these are placed the transformers used to supply the station lighting and power and the lighting and power for the local camps. In the rear of these compartments are those protecting and supporting the high-tension bus-lines.

On the second floor are placed the generator oil-switches and bus-bars, mounted in concrete compartments and behind them, in their various compartments, the high-tension disconnecting switches, oil-switches and series and shunt transformers. The main

switchboard is also on this floor at the west end of the building. This will eventually be the center of the building, when the plant is completed.

The exciter sets are on the main floor at the west end, but like the switchboard, will be in the center when the installation is completed. On this floor and directly under the main switchboard is the local switchboard. This consists of eight slate panels and contains the switches for the exciters, generator-fields, station circuits, motors operating gates on header-pipe and the circuits to the various camps.

Underneath the main floor of the rear bay are spaces for storing heavy materials for the various uses about the station. From the ceiling, supported on slings, are four transformer oil storage tanks, supplying, through a system of piping, oil, as needed, into the transformer tanks.

Beneath the floor of the forward bay are a series of rooms connected from end to end of the building by a passageway, in which are contained the step bearings supporting the vertical shafts of the main generators. The generator field rheostats are also in these rooms.

Directly under these rooms is another similar set of rooms, in which are the operating mechanism of the main water-wheels and two sets each of triplex oil pumps, one set being operated by a shunt-wound d.c. 20-h.p. motor, while the other is driven by a 10-in. belt directly from the main shaft.

At the switchboard end of the station both of these floors are lowered several feet. On the lowest of them there are two rooms, the first being used as a machine shop. It contains a shaper, an 8 in. by 20 in. engine lathe, emery-wheel, hacksaw, two drill presses and a pipe-threading machine. The second room contains a 10-in. centrifugal pump, directly connected to an 85-h.p. induction motor for pumping out a sump, still lower than this floor, into which any water that might seep into the building when the river is very high, will run. There are also in this room an auxiliary storage tank for filtered oil and a triplex oil-pump to supply pressure at 215 lb., as an auxiliary for the governor and bearing system, also an injector pump in the sump.

In the space over these rooms are two railway-car air-compressors to supply compressed air for operating the remote-control switches. An air-storage tank is suspended from the ceiling. There are two oil-storage tanks and two oil filters. An additional 10-in. centrifugal pump driven by an 85-h.p. induction motor, for pumping water, has been installed, to be used in emergency.

Near each main generator is a winding stairway which passes through the step-bearing room to the wheel room. There are also gratings in the floors to allow the handling of heavy pieces of machinery by the traveling crane.

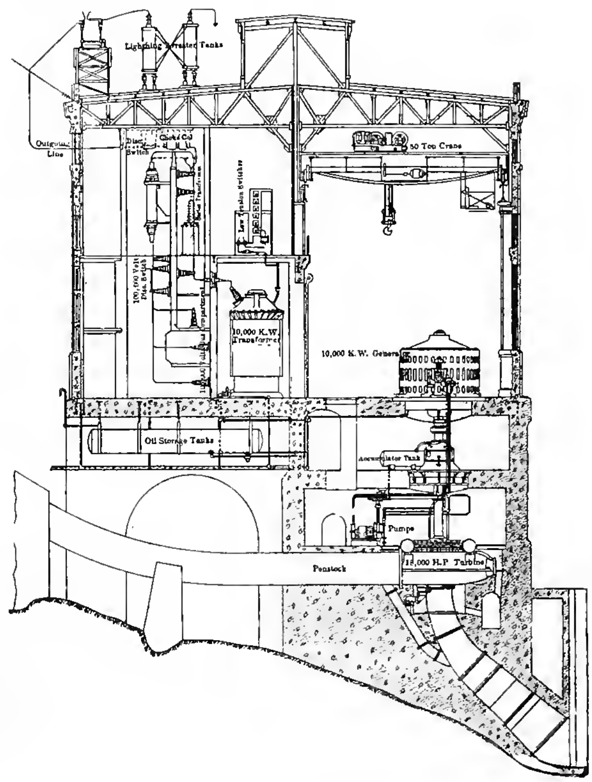
The Waterwheels.

The four main waterwheels are inward flow Francis type turbines, and the largest, in point of output, of any yet built. They have a bronze runner, operating within a cast-steel volute casing, through which water to the runner is supplied.

The pressure-pipe or penstock is brought directly to the casing, without a gate valve. This arrangement is satisfactory, from the fact that the pipe-line is comparatively short, each turbine has its own pipe-line and the motor-operated gate-valve at the head of the steel pipe fulfills any function for which a gate-valve at the turbine might be used. It further reduces complication in the powerhouse equipment. The draft-tube is of cast-iron, in sections, bolted together.

Provision has been made, at a point in the casing, corresponding with an opening in the front wall of the building, for attaching a relief-valve, should this expedient be found necessary. So far relief-valves have not been installed. The casings were designed to withstand any extra pressure, due to surges, without the use of this auxiliary equipment.

Cast-steel guide vanes distribute the flow to the runner; these are mounted in the usual manner, on steel spindles, which are brought up through stuffing



Cross Section through the Powerhouse.

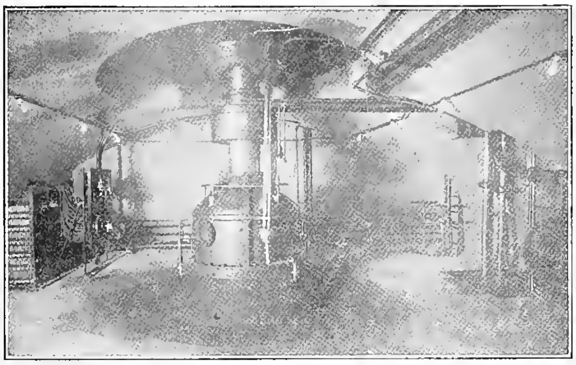
boxes and terminate in a bell-crank. They are operated through links, by a movable ring, which in turn is connected to and operated by the pistons of the governor cylinders. The vane-faces of the runners are carefully finished to reduce losses by friction. Directly above the runner is a guide-bearing carried by the cover of the turbine.

The total weight of the revolving parts, including the shaft and the rotor of the generator is 145,000 lbs.; that of the turbine proper is 25,500 lbs. This weight is carried by an oil-disc step-bearing. The latter is made up of two discs; the lower one being stationary and supported by the arch floor of the compartment, already described. The upper disc is a tight fit against a shoulder, virtually a part of the shaft, and thereby carries the entire weight of the moving mass. Oil, under a pressure of 215 lb. per square inch is fed into an annular compartment, between the lower disc and the shaft, discharging at the periphery of the

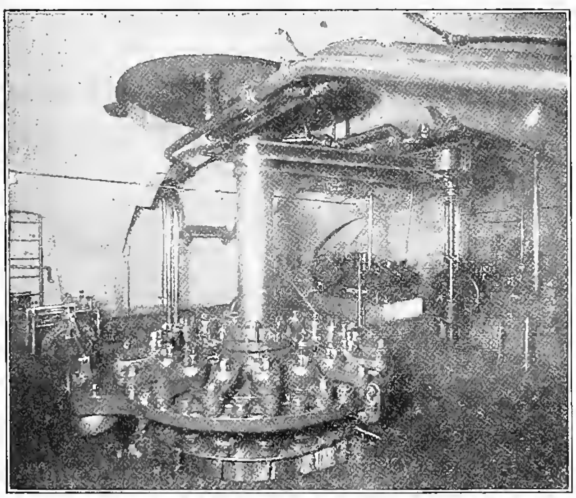
discs. This discharge automatically keeps the discs separated, so that the upper one is always turning on a film of oil.

The triplex pump in the turbine chamber, driven by a belt from the shaft, supplies oil to the step-bearing. The second triplex pump, operated by a motor, supplies oil under 215 lbs. pressure, to operate the governor cylinders.

The governors are placed on the main or generator floor. They are of special design for this installation, and are known as the double floating-lever type. The controlling cylinder in the governor is connected through brass piping with the operating cylinders, which move the turbine gates and which are mounted on the turbine casing.



Chamber Containing Step-bearing and Generator Rheostats.



Chamber Containing Turbine and Controlling Mechanism.
Triplex Oil Pumps on the Right.

A regulator in the discharge pipe to the pump maintains a uniform pressure in the system. There is a tank between the pump and the governor, which acts as a reservoir and a proportion of three of air to one of oil in the contents of this tank is maintained by the pressure regulator. When no oil is being fed to the governor, during periods of constant load, the pressure on both sides of the regulator is equalized and the oil from the pumps is discharged into the step-bearing, which acts as a relief valve.

Both the governor pump and the step-bearing pump receive their supply of oil from a rectangular sheet-steel tank, placed in an opening, below the floor of the turbine chamber.

The turbine may be operated by hand should the governor fail, by a small valve on top of the operating cylinders, or, in an emergency, arrangement has been made whereby water under pressure from the wheel case can be turned into one of the cylinders and thereby shut down the turbine.

A safety device, to prevent a runaway, is provided as follows: Immediately above the step-bearing, fastened to the lower side of the coupling flange on the shaft, is a movable arm, pivoted at one end and held by a spring, so that it will be thrown outward by centrifugal force if the speed of the turbine should increase a determined percentage above the normal operating speed. This arm will engage a toothed segment, which is mounted on a shaft and operates a valve, which, in turn, operates on the relay valve in the governor. This shuts down the turbine.

In designing the turbines, a severe condition had to bet met, it has already been explained, that the full operating head, upon the completion of the high intake-dam, will be about 535 ft.; but that, until such a time as the dam is completed, the head will be 430 ft.

It was necessary to adopt a design which would operate at the ultimate and higher head, under the best condition of efficiency and also be capable of essentially as good efficiency while operating at the lower head. This condition seems to have been met in these turbines, a series of tests, which have been made, showing the efficiencies to be as follows:

Load.	Builders' guarantee.	Approximate test results.
½	76%	65%
¾	82%	80%
1	80%	81%

These tests could be made only while operating under the lower limit of head and with the full speed of 400 r. p. m. Water was measured by the use of Pitot tubes. A water rheostat was the means devised to give a unity power-factor load for the generator.

The Generators.

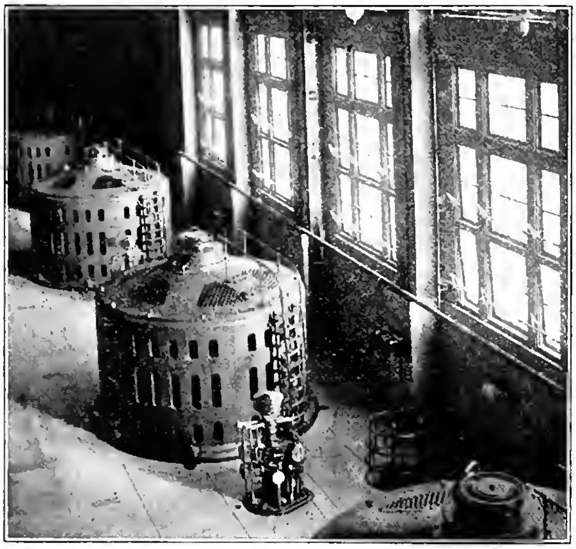
The main generators are the largest of their kind in existence and are of the vertical shaft, revolving field type. They are rated at 10,000 k. w. and deliver three-phase, 60 cycle current at 11,000 volts.

The stationary armature is directly supported by the main floor structure. It contains two guide-bearings, one above and the other below the rotating field. The armature winding consists of flat bars, there being two coils per slot and nine slots per pole. There are three star-connected windings, in parallel. Each winding occupies one-third of the armature surface or 120 degrees.

The rotor was especially designed for this installation. Before shipping, they were tested to double the normal speed of 400 r. p. m.; as the diameter is over 9 ft. the peripheral velocity during this test was 23,000 ft. per minute, over 4 miles per minute. This severe condition called for an unusual design; the pole-pieces are dove-tailed into the structure and the field coils are supported at their ends, to resist centrifugal force, by steel discs. The entire design allows a maximum of ventilation without adding to windage losses.

To bring the revolving element to a standstill quickly and to prevent starting, due to leakage in the waterwheel, a hydraulic brake is fitted to a ring, fastened to the lower side of the rotor.

Lubricating oil for the generator guide bearings is fed by gravity through a system of brass piping. The tanks supplying this oil are located in one of the compartments, between the main transformers and are suspended from the ceiling of the compartment, to give the necessary pressure to the oil. A motor-operated rotary pump returns the oil after it has been filtered, to the tanks.



Main Generators and Governors.

Following are the results of tests made of these machines, together with the guarantees made by the manufacturer:

	Guaranteed.	Actual.
Full load	96.9%	97.1%
Three-quarters load	96.0%	96.4%
One-half load	94.5%	95.0%

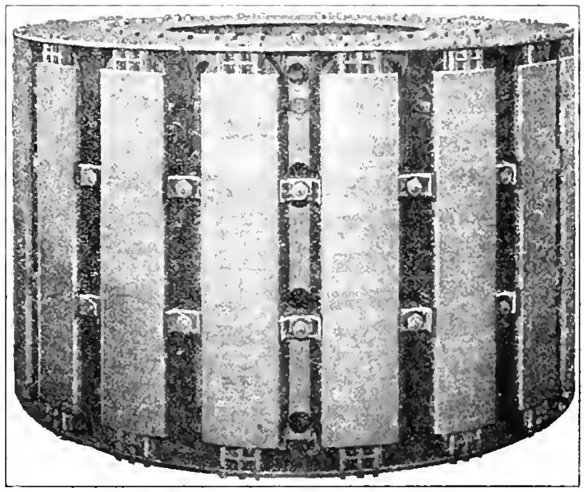
Temperature rise within the 40 degree cent. limit.

The Exciters.

There are two exciter sets. Each is driven by a tangential type waterwheel of about 350 horsepower. The waterwheel is enclosed in a cast-iron casing and is equipped with a needle--nozzle, operated by a Woodward governor, mounted on the nozzle structure.

The discharge is caught in a sheet-iron tank or basin, which delivers it into a 24-in. cast-iron pipe and by which it is carried down, through the lower compartments and the front wall, to discharge into the river. No attempt is made to maintain a draft on these waterwheels.

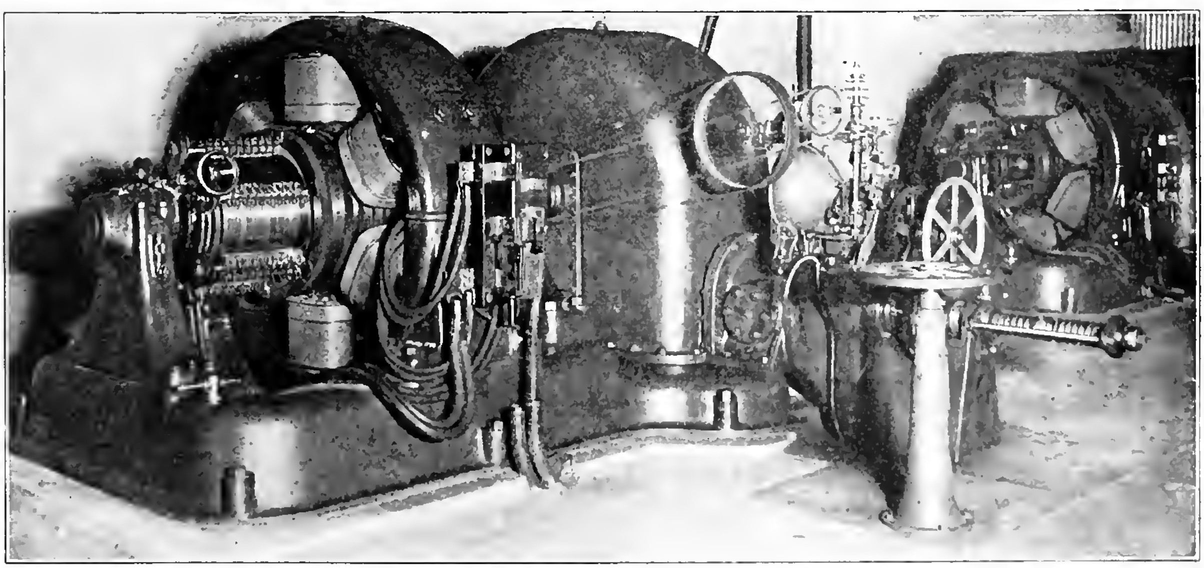
The generators are each 250 k. w., 6-pole, 250-volt d. c. machines and operate at a speed of 500 r. p. m.



Rotor of a Main Generator.

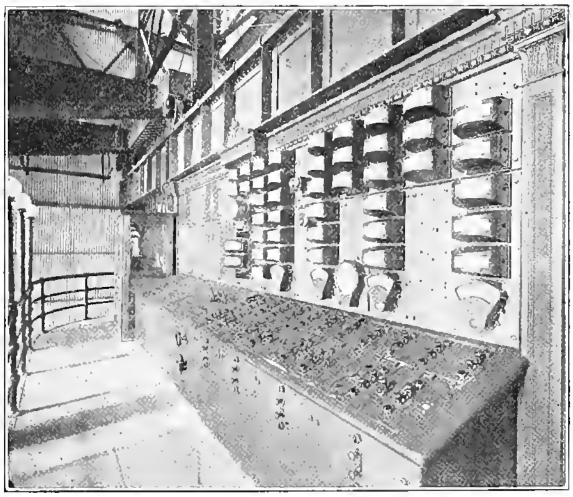
The Switchboard.

The generator circuits and the outgoing transmission lines are controlled from the main switchboard. This is so placed on a balcony, extending into the main bay, from the second floor, that the attendant may be at all times in view of the machines, and have a general supervision of the building.



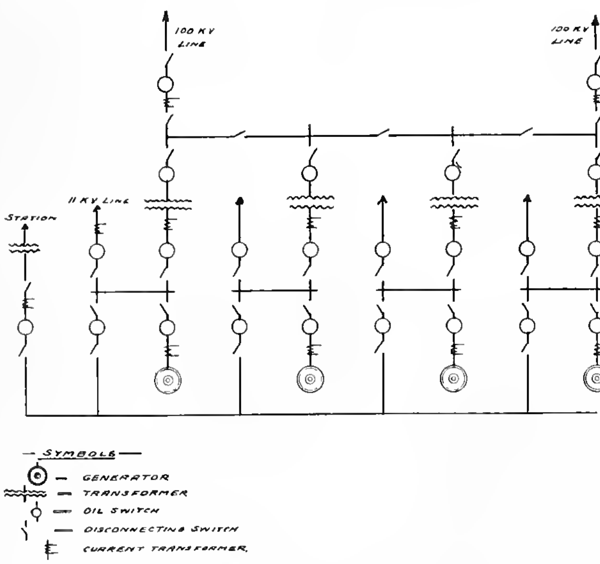
Exciter Machines.

The switchboard is of the standard bench-board type, with panels for each generator and its transformer and for the transmission lines. Mounted on the panels are all of the instruments necessary for the operation of the circuits, in conformation with modern practice.



Main Switchboard.

Attention is called to a cut which shows the arrangement of all main circuits, as diagramed on the bench-board. The switchboard is installed for eight generators, but equipped only for the present installation.



Arrangement of Main Circuit in the Powerhouse.

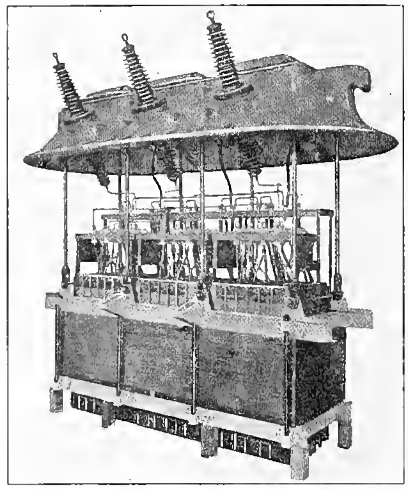
A synchronizer with 3 ft. dial is mounted on a pivot, on an arm at the edge of the balcony, in such a manner that it may be turned for observation from any part of the building. Current for the instruments is supplied from series and shunt transformers, in the main circuits.

The Transformers.

Each generator feeds directly through ducts under the main floor and remote-control oil-switches on the second floor, its own three-phase transformer.

The transformers, like the generators, exceed all others in size and output. They are interesting in that they differ in design from most large transformers, due to their great size. The shell-type of construction with flat coils, is used. As these transformers are three-phase, there are three separate groups of coils, one for each phase.

The iron core, as in the single phase type of transformer, passes around and through each group of coils, a continuous construction, however, surrounding the whole. The advantage of this arrangement, instead of using three separate cores, is a saving in space and weight; the amount of iron saved being 25 per cent of the amount necessary for separate transformers.



Core and Cover of 10,000-Kilowatt, Three-phase Transformer.

Each set of coils is made up of sixteen high-tension coils, having a total of 1,328 turns and ten low-tension coils. The coils are all wound with solid copper ribbon, having a rectangular section and are one turn per layer. Each coil is completely surrounded with a covering of insulating material and between them are placed sheets of pressboard. Spaces are left between the coils and the pressboard barriers, to permit of the free circulation of the transformer oil, for both insulating and cooling purposes.

The high-tension winding is designed to deliver a potential of 100,000 volts, but has a number of taps for lower voltages. The low-tension winding is designed for 11,000 volts and has taps to give approximately 5 per cent and 10 per cent increase or decrease in voltage, above or below the normal.

The cover for the transformer case is supported by and bolted to the core, so that in lifting the cover the core is brought out also.

The low-tension leads are carried through the cover in porcelain bushings; the high-tension leads are also carried by bushings in the cover. The latter are made up of a series of short segments, between which are placed fibre rings of somewhat greater diameter. These rings are for the purpose of lengthening the leakage surface of the bushing. Within the bushing are concentric fibre tubes. The conductor passes through the center of the tubes and the whole

is filled with oil. A gauge at the top of the bushing indicates the height of oil within.

Heat from the circulating oil is absorbed by the water which is forced through the copper cooling coils. These are suspended from the cover. The oil with which the transformer is surrounded is a specially refined product and a motor driven air-pump is especially provided to exahust the air in the transformer case before the transformer is placed in operation for the first time.

The case is of riveted sheet-steel and is riveted to a cast-iron base. In the base are four flanged wheels. Two rails imbedded in the concrete floor extend from the transformer cells into the main bay and on these the transformer cases, at all times, rest. By this means the transformer may be moved forward, until it can be picked up by the traveling crane.

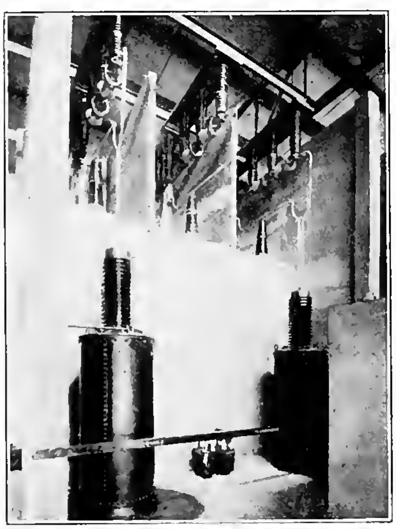
The total weight of the transformer and case is 191,000 lb., divided as follows: Core, 68,000 lb.; case, 60,000 lb.; oil, 63,000 lb. The amount of oil necessary is about 9,000 gallons.

The regulation, while delivering 10,000 kilo-volt-amperes, with 100 per cent power-factor, is 1.05 per cent; but with the same load and 80 per cent power-factor, it is 3.1 per cent.

The efficiencies at various loads are very high. They are:

Full load	98.6%
Three-quarter load	98.4%
One-half load	98.0%
One-quarter load	96.4%

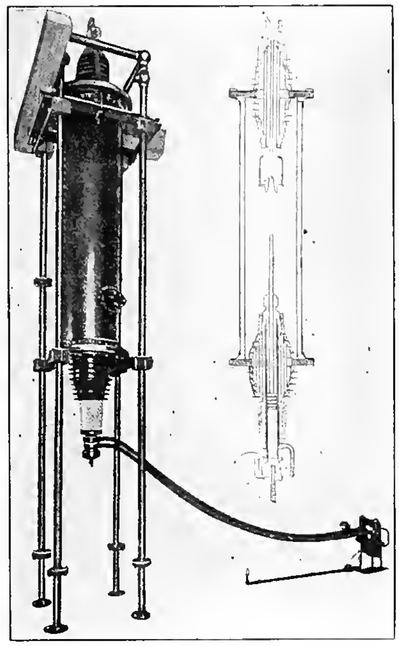
After leaving the transformer, the conductor passes through an oil-switch, to a disconnecting-switch, and then to the bus-lines. From the bus-line the circuit is carried through oil-switches to series-transformers (there are but two of these in each circuit, the third wire is therefore not brought into the



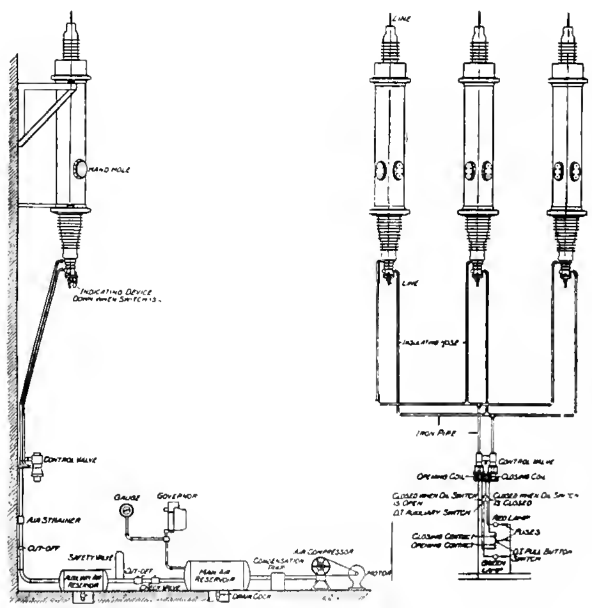
100,000-volt Series Transformers. The Small Transformer shown are for 11,000 volts. Note the Difference in Size.

series-transformer compartment), and continued to a disconnecting-switch, thence, passing through double windows of ¾-in. plate glass to the transmission line.

The oil-switches are of the single-pole, single-break piston type and consist of a cylindrical oil chamber. Inserted within its upper extremity is the receptacle which receives the switch-point upon closure of the circuit. At the lower end is a smaller cylinder containing a piston to which is mounted the point of the switch. This piston is operated by compressed air, supplied through a flexible and specially treated rubber hose. The operation is electrically controlled from the switchboard. There is a mechanical indicator on



100,000-volt Single-pole Pneumatically Operated Oil Switch.



Diagram, showing Mechanism to Operate 100,000-volt Oil Switches.

the switch, to show its position, aside from the indicating lights on the bench-board.

Air to operate the switches is supplied at 80 lbs. pressure and the direct-current, for electrical control, at 250 volts. A small air storage tank of three cubic

feet capacity is mounted on the rear wall of the building, for each switch, to provide sufficient air to operate the switch, in case the main source of supply should fail.

The insulator bushings at the top and bottom of the oil-switch are, in general, similar to those in the covers of the transformer cases, except that they are filled with an insulating compound instead of oil.

Between the transformers and the transmission lines the conductor is made up of 1-in. round aluminum tube. This is not so much for the purpose of giving ample carrying capacity to the conductor, but, by its large diameter, does away with what is known as a corona effect, a static discharge, due to high voltage.

Lightning Arresters.

Mounted on the roof of the powerhouse are two sets of aluminum eletrolytic lightning arresters. These are severally connected to the transmission line wires, through spark-gaps, in the usual manner.

Operating Arrangements.

The powerhouse is in charge of a general foreman, who has control at all times. There are three eight-hour shifts, each consisting of five men, as follows: Shift foreman, switchboard operator, machine attendant (main floor), waterwheel attendant or oiler, and one man about the step-bearing compartments who oils and cleans up. Considering the size and the complication of parts of this plant, this is a small operating force and speaks well for its efficiency.

Transmission System.

Ten years ago the transmission of electricity over long distances had become a fairly well understood commercial possibility. Engineers, who, previous to that time, had been obliged to specially design and build much of the apparatus as was necessary to successfully operate their plants, were beginning to purchase standard equipment. The long-distance transmission of power was an established certainty. But if a company had existed who could supply and were bold enough to attempt to transmit, 54,000 h. p. a distance of 154 miles, the feat would have been one at which the most daring designer would probably have balked.

The increase in power quantity and the accompanying necessity for higher voltage has required a corresponding advance in the art of structural design for this purpose and the most notable achievement in this feature has been made at the vital point—that of support of the electrical conductors.

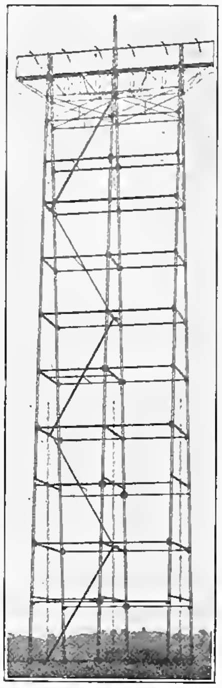
First there was the structural steel tower, to replace the wood pole, and then came the suspension insulator, which, of the two improvements, is probably the most important. The tower could be built safely to a greater height than the pole and thereby allow of longer span for the conductor, which meant fewer points of support—fewer points of danger from grounding and interruptions to service.

The suspension insulator provided a natural and flexible means of supporting the wire, and by virtue of its articulated construction, of a number of separate insulator discs in series could, by making that number sufficient, resist any voltage stress that might be impressed.

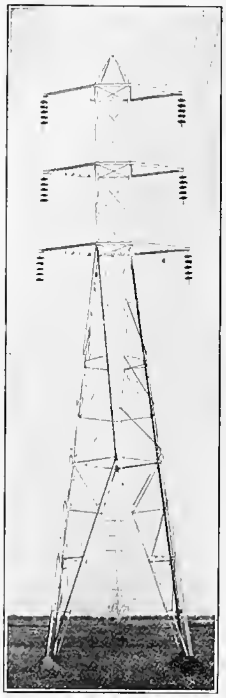
The transmission line from the Big Bend powerhouse to Oakland embraces the results of the experience of the earlier transmissions and is up to date in design and construction. It fulfills the requirement that would have been impossible of accomplishment a decade past.

There are an average of seven Milliken steel towers per mile—1200 in all. In the mountain sections, the spaces between them vary, as the highest points of ground were naturally selected.

The height from the base plates to the extreme top is 77 ft., 6 ft. being below ground. There are three cross-arms of equal length placed one above another and ten feet apart. Once in every $3\frac{1}{2}$ miles there is a tower where the upper arm is attenuated to carry four wires. This is for the purpose of transposition, or spiraling of the circuit, to neutralize effects of mutual induction.



Special Transmission Tower for Long Span.



Standard Transmission-line Tower.

Wherever rivers are crossed, special towers were erected to meet the conditions encountered; these vary in height from 150 ft. to 290 ft., the latter figure being that of the towers spanning the lines over the delta of the Sacramento River near Antioch. In marshes and other soft places, piles were first driven to give suitable foundation to the towers.

From each end of the arms is hung the insulator. These are of the Locke, Thomas and General Electric types, but all consist of four and five brown porcelain discs. These discs are fastened together by steel links imbedded in and inter-connected from the upper and lower side of the porcelain in such a manner that if the porcelain should be shot away or otherwise broken, the links would remain fastened together. From below the lowest disc the wire is supported by a substantial clamp, held by one hook bolt, six being used where strain occurs.

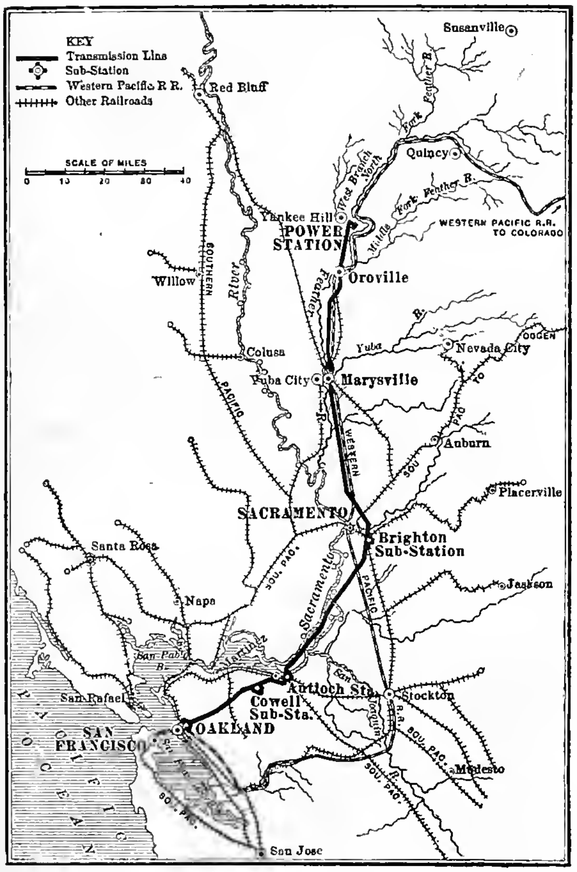
The insulator is free to swing from the arm and

for this reason, on every angle, or at other points where the line strain may pull against the tower, there are strain insulators. These are similar to the others, except that two sets are used. The wire is dead-ended at the insulator, so that the latter stands out from the arm in line with the wire, and carries the strain of the line directly to the structure. The two cut ends of the line are then bridged with a section of wire suspended between them.

The insulators are tested to a break-down voltage of 200,000.

The initial line voltage is 110,000.

The two three-wire circuits are of No. 000 M. H. D. copper, 7-strand cable, and the length of transmission from the power-house to the Oakland sub-station is 153.5 miles.



Map of Water-shed and Transmission System.

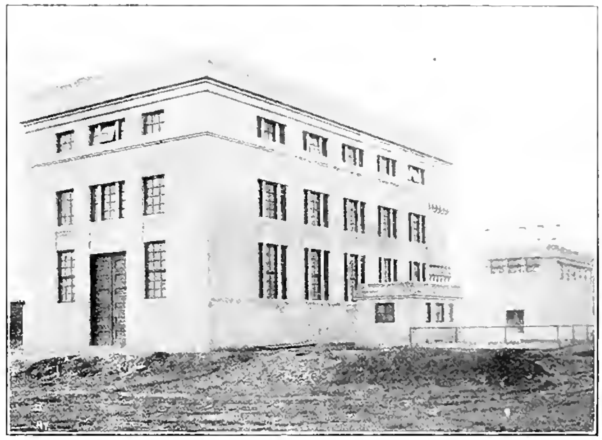
There is a 3/8-inch steel cable ground wire running the entire length of the line and fastened to the topmost point of the towers. A telephone line of No. 8 solid copper wire is also carried, at a point about half-way between the lowest power wires and the ground.

The towers were, when first erected, simply set in the ground, except at points where ground conditions were unfavorable, earth being tamped over and about the ground plates. It was thought that sufficient stability would be secured by this method. Discovery was made that a more stable fastening was necessary at some points, accordingly the tamped earth was removed and the hole filled with concrete, which was built up well above the ground. This expedient has been entirely successful.

The full load loss, if the entire load should be delivered to the terminus of the line, would be 15% and the regulation drop about 24%, depending upon the power factor of the load.

Sub-Stations.

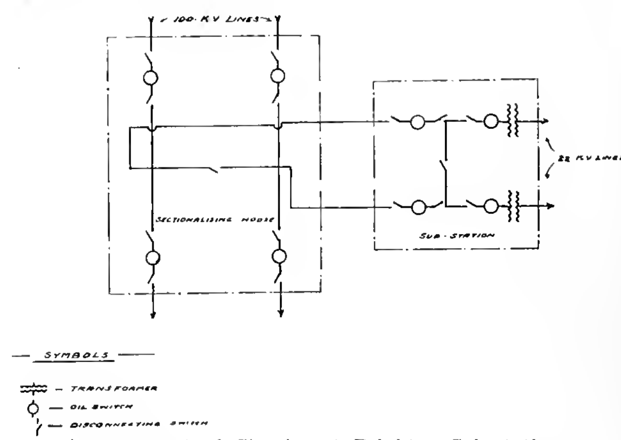
There are three sub-stations; the first, at Brighton, a suburb of the city of Sacramento; the second, at the Cowell Portland Cement plant, near Concord, and the third, at the terminus of the transmission line in the



Sub-station at Brighton, showing Sectionalizing-house in background; Pumphouse and Cooling Tank in right foreground.

city of Oakland. The first and last of these sub-stations are elaborate, commodious and well built, the Cowell sub-station is somewhat smaller, but of similar design and finish.

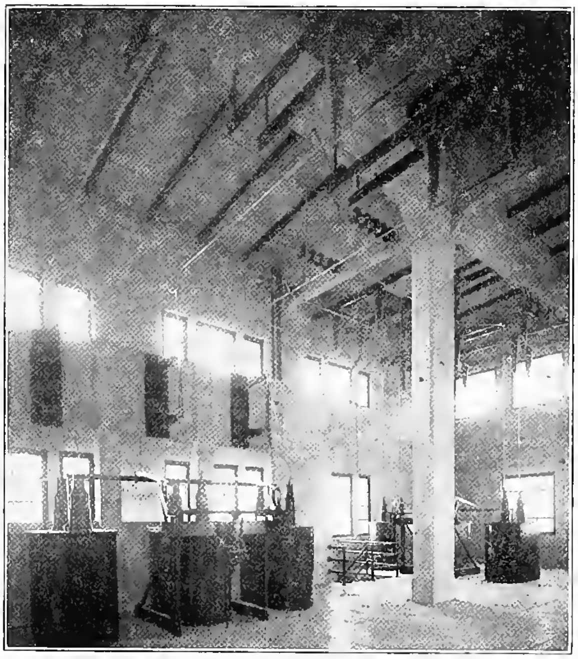
The Brighton sub-station consists of three buildings, a sectionalizing house, a pump house and the sub-station proper. The sectionalizing house, 30 ft. by 50 ft. and 30 ft. high, of reinforced concrete with slab roof, supported by steel trusses, contains the line switches and cut-outs.



Arrangement of Circuits at Brighton Sub-station.

Both circuits of the transmission line are brought into the building, through porcelain bushings, supported at the center of double 3/4-in. moulded glass windows, 5 ft. square. The lines are carried to disconnecting switches, mounted on the wall directly under the windows, and from these to the manually

operated oil-switches, which are placed on the floor of the building. From the oil-switches, the lines are carried to the roof to a second set of disconnecting-switches. Beyond these there is a bus-section and then the arrangement just described is repeated in reverse order, the lines passing again through windows to continue the transmission. Between the bus-sections is a connecting line containing a set of disconnecting-switches. From each bus-section there is a circuit, one passing through windows at one end and the other through windows at the other end of the building, running to the sub-station building.



Incoming-line Oil Switches; Disconnecting Switches on Right. Transformer Oil Switches and Disconnecting Switches on Left; Brighton Sub-station.

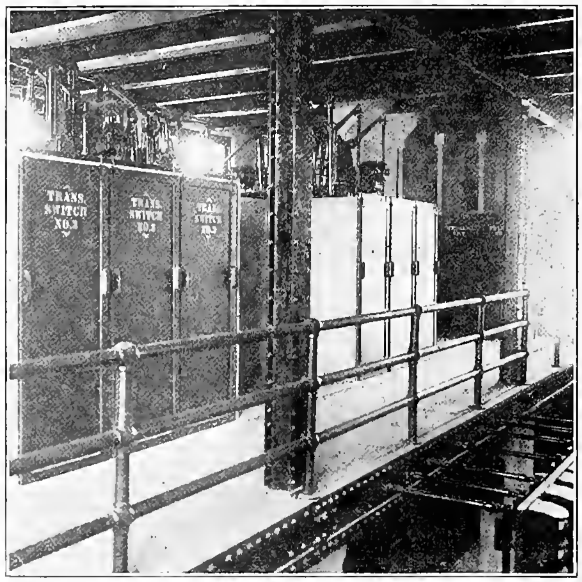
This sectionalizing house permits of the cutting the transmission into two almost equal halves and allows of any arrangement of circuits or connection to the sub-station that may be desired.

The disconnecting-switches are merely a long bladed knife switch, operated by a hook at the end of a long wood pole. Each end of the switch is mounted on a porcelain column insulator and these are in turn fastened to a wooden block about 3 ft. in length.

The oil-switches are known as the "K-10 type." They consist of a large sheet-steel tank with dome-shaped, cast-iron top, filled with oil. The two lines are brought through the cover in insulator bushings; these are made up of segments, separated from one another by fibre barriers, containing insulating compound. The switch proper is a horizontal bar suspended at the lower end of a wood arm, which in turn is operated in an up-and-down direction by the mechanism mounted on the outside of the case. On closing the switch, the horizontal bar engages at its ends with the spring clips suspended from the bushings and directly undeneath them.

The writer was informed that the circuit, while carrying a load of 10,000 kilowatts and a potential of over 100,000 volts, has been interrupted on short circuit by these switches, without apparently the slightest disturbance of an unlooked-for or dangerous nature.

The main sub-station building is of reinforced concrete of classic design. It is 100 ft. long and 50 ft. wide and contains three floors. The six wires of the two incoming circuits enter the upper floor, through windows similar to those in the sectionalizing house. Each conductor passes through a disconnecting-switch, then to an oil-switch and beyond this to another disconnecting-switch, from which it connects to a bus-line. There are accordingly two bus-lines, suspended from the roof and running lengthwise of the building. There is a connection between the bus-lines, opened by disconnecting-switches. The leads to the transformers, on the lower floor, are taken from the bus-lines, each passing through first, a disconnecting-switch and then an oil-switch. The disconnecting-switches are operated by hand, but the oil-switches are electrically operated and controlled from the switchboard.



22,000-volt Oil Switch Compartments and a Corner of the Switchboard, Brighton Sub-station.

The transformers are arranged lengthwise of the building and on either side. There is space provided for twelve of them, but six are at present installed. Each transformer has a capacity of 1,250 k. w. and are delta connected, both on the primary and the secondary sides; the voltage ratings are, respectively, 90,000 and 22,000. Arrangement for rapidly draining the oil is provided for, should a burnout occur.

The 22,000-volt out-going circuits are connected through electrically operated oil-switches and disconnecting-switches, placed in concrete cells. These switches, the two bus-lines and the series and shunt transformers for the switchboard instruments are placed on two floors, across the end of the building. A 10-panel slate switchboard is placed on the main floor, directly in front of the switch-compartments.

There is a depressed track, laid lengthwise of the building, down the center. A low transfer car runs on this track, its platform being at the level of the

floor and supporting a transverse track. This car may be run to a point opposite any transformer. The transformers being mounted on wheels which, in turn, run on rails imbedded in the floor and which correspond with the rails on the transfer car, may be moved on to the car and thus transferred to any other point in the building. A 12-ton Yale & Towne triplex chain-block, suspended from the roof, through an opening in the upper floor, will pick up loads to be handled by the transfer-car. A small air-compressor set is provided, for cleaning purposes.

Direct current for operating the oil-switches throughout the building is supplied by a 10 k. w. motor-generator set. This set has its own switchboard and the motor is equipped with a variable speed device. At the end of the shaft is a steel disc fly-wheel, 40 in. in diameter. The normal operating speed is 1,800 r. p. m. Should the line current fail this set, from the inertia of its fly-wheel, would run for several minutes, thus providing for the operation of the switches in the interval.

Oakland Sub-station.

To one side of this building, but separated from it, is a well-house and a spray-tank, from which water to cool the transformers is supplied. The former is a low concrete building 20 x 10 ft. in size, with its floor 10 ft. below the ground surface. In the building are two 5 h. p. motors which drive Krogh contrifugal pumps, together with a system of pipes and valves, which permit of the forcing of water from the well, directly to the transformers, to return to the tank, or from the tank to the transformers and return through a spray. There are also fire-hose connections.

A particularly noticeable feature, especially in and about the sectionalizing house, is the continuous buzz of minute static discharges into the atmosphere, due to the 100,000 volts line pressure and the accompanying strong odor of ozone. This does not represent any appreciable loss and is in no sense a source of danger.

There are at present two 22,000-volt feeders of two circuits each, one to the city of Sacramento and the other to the gold-dredger district near Folsom, and a single circuit line of the same voltage to supply power for pumping along the Sacramento River.

The Oakland sub-station is somewhat different in arrangement, but similar in general design to the one just described. There is no sectionalizing house, this feature being unnecessary at the end of the transmission line. This sub-station contains two 10,000 k. w., three-phase transformers, similar to those at the powerhouse, and three 5,000 k. w., three-phase transformers, the high-tension side being wound for 90,000 and the low-tension for 55,000 volts.

There are two feeders from this sub-station; one carrying current at 55,000 volts to the Ridge substation of the Pacific Gas & Electric Company, with whom this company has a contract to supply power; and the other at 11,000 volts to the steam auxiliary plant owned and operated by this company and located at tide-water on the Oakland Estuary. (Described in the Journal of Electricity, Power and Gas, Dec. 25, 1909.)

The first of these feeders has a single three-wire circuit of No. 000 copper cable. It is carried part of the distance on the regular type transmission towers, already described, until it joins a transmission line of the purchasing company. On the latter section of its course it is carried on standard triple-petticoat insulators.

The second feeder line is in three circuits, all of No. 000 copper cable, mounted on 7-in. 2-part porcelain insulators and supported by wood poles. From one of these circuits a branch line is run to the Piedmont sub-station of the Pacific Gas & Electric Company.

All the engineering design of the plant except the proposed new dam was under the direction of Viele, Blackwell & Buck of New York, and Mr. M. A. Viele, senior member of the firm, had direct charge of its construction. The new dam is designed by Mr. John R. Freeman, C. E., of Providence, R. I., who is responsible for its engineering features. Its construction is being done by the Great Western Power Company.

The electrical equipment, except where otherwise noted, was supplied by the General Electric Company and the hydraulic apparatus by the I. P. Morris Company.

The writer desires to express, in behalf of the Journal, his appreciation of the courtesy and assistance tendered by Mr. H. H. Sinclair, Mr. G. R. Field and Mr. J. P. Jollyman, respectively manager, assistant manager and electrical engineer for the company, in the preparation of this article.

ENGINEERING DATA OF THE GREAT WESTERN POWER COMPANY'S SYSTEM.

Hydraulic Equipment of Power House.
Dam Height 140 ft.
Hydraulic Conduit Length 15,710 ft.
Capacity 2,500 sec. ft.
Static Head 430 ft.-535 ft.
Waterwheels, 4 Francis 18,000 h. p. turbines.
Exciter wheels, Tangential Type, two 350 h. p.

Electrical Equipment of Power House.
4 10,000 k. w. generators, vertical type.
4 3-phase raising transformers, 10,000 k. w.
11,000-100,000 volts, delta connected, both sides.
11,000-volt switches, electrically operated.
100,000-volt switches, pneumatically operated, elect. contr.
Lightning Protection—Aluminum electrolytic cell arresters.

Transmission Line.
Length, 154 miles.
Milliken steel towers, 7 per mile.
Circuits, 2 No. 000 copper, 7-strand wire.
Insulators, suspension type.
Telephone wire, No. 8 M. A. D. copper.
Ground wire, ⅜-in. steel cable.

Sub-Stations.
3. Brighton, Concord, Oakland.
Brighton, six 1250 kw. 90,000—22,000 volts.
Concord, four 1250 kw. (1 spare) 90,000/440-volt.
Oakland, two 10,000 kw. 100,000—11,000; three 5,000 kw. 90,000—55,000 volts.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER IV.

THE COMMUTATING TYPE OF WATTHOUR METER.

(Continued.)

The Use of the Commutating Meter on Alternating Current Circuits.

As previously explained, the commutating type meter is a simple shunt motor, and this being the case, the question may arise, "Why is it that such a meter can be operated with accuracy on alternating current circuits?" It should first be remembered that, owing to the iron in the magnetic circuit of an ordinary shunt motor, there would be a great difference in phase relation between the current in the armature and the current in the fields if such a machine was supplied with alternating current, this being due to the much greater inductance of the field winding. The current in the fields would lag almost 90 degrees behind the current in the armature, therefore the torque produced would not be sufficient to cause rotation. The meter, being as it is, devoid of iron in its magnetic circuit, will not suffer from such a phase difference when supplied with alternating current.

The commutating type of meter can be made to operate with accuracy on alternating current circuits by making an adjustment which is termed "lagging." If this type of meter is used on alternating current, precisely the same as on direct current—that is, without any adjustments—the current in the armature will lag a few degrees behind the impressed voltage, while the current in the field coils, for a load of unity power factor, will be in phase with the impressed voltage; the lag in the armature current being caused by the inductance of the armature and the compensating field. This, however, does not introduce a serious error at unity power factor. In order that the meter may register correctly on power factors other than unity, it is necessary that the current in the armature be in phase with the current in the series field when the meter is operating on a load of unity power factor. It is therefore necessary that an adjustment be made that will bring the two currents in phase, thereby correcting the small phase difference above referred to. Such an adjustment is accomplished by shunting a part of the current in the series fields through a non-inductive resistance. By properly adjusting this resistance, the current in the series fields can be made to "lag" until it is in phase with the armature current.

The principle or theory of this method of adjustment may be explained as follows: The series coils have both resistance and inductance, and when shunted by a non-inductive resistance, the line current is divided into two components, one of which flows in the non-inductive resistance and the other in the field coils themselves. (The current in the non-inductive resistance is a small percentage of that flowing in the field coils.) The relative values of these two components of the line current are inversely proportional to the impedances of the two paths, and the phase angle between them will depend upon the ratio of the resistance to the reactance of the series coils. This is diagramatically shown at (a) in Fig. 47, where OV represents the impedance drop around the series coils and the non-inductive resistance together; i being the current in the resitance and i′ the current in the series field coils. The voltage drop, Ri, in the non-inductive resistance, will be =OV, and i will be in phase with OV. The drop in the series coils, however, consist of two components, a resistance drop, R′, i′, which is in phase with i′, and a reactive drop xi′ at 90 degrees from i′, the phase angle between i and i′ being represented in the figure by ϕ.

The main line current is made up of these two components as shown at (b) in Fig. 47, and it can be seen from this that the angle β, which is the lag of the current i′ in the series coils behind the line current I, can be adjusted by merely changing the value of the current i in the non-inductive resistance.

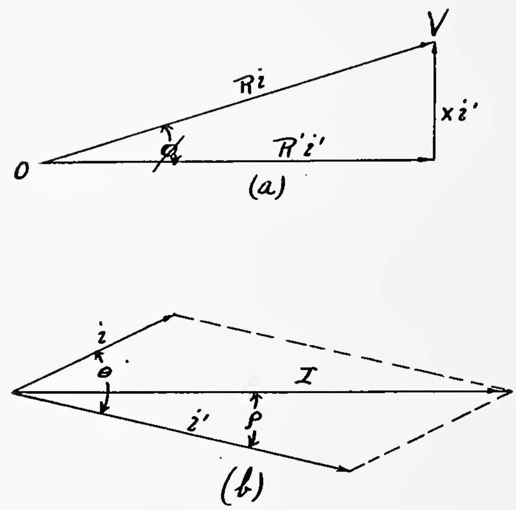


Fig. 47.

After having properly lagged the meter on say 50% power factor, it is necessary to recalibrate it, since the torque exerted by the series coils will be less than before the adjustment was made, as the total line current is no longer flowing in the series coils. This recalibration is made by adjusting the retarding magnets, after which the meter will be accurate for all power factors above 50%. An unlagged commutator meter will have a tendency to run fast on inductive loads. In any event, where it is necessary to lag commutating meters it is advisable to take the subject up with the manufacturer of the meter in question, and obtain their recommendations. In all cases involving a great number of meters, it is advisable to change the entire installation over to the induction type on account of its greater simplicity and superior operation on alternating currents.

Three-Wire Meters.

In the heart of cities, and in buildings where a large amount of current is used, the three-wire system of distribution is almost always to be recommended on account of the great saving in the amount of copper in the distributing wires, the most common system

being the 220/110-volt system, the current being furnished (in case of direct current) by either a three-wire generator, a two-wire generator with a balancer set, or by two generators operating on a three-wire connection. The question often arises as to what extent should the distributing company insist upon having the system balanced. In New York City the requirements are very rigid. For instance, all lighting circuits taking more than five amperes must be equally divided between the two sides of the system, and all motors over 5 h.p. must be connected across the outside wires. On the other hand, some companies pay no attention whatever to the "balance," and depend upon the average conditions to balance the load at the station bus-bars. At the point of distribution, however, the conditions may not be so favorable as at the station, thereby resulting in poor service on one side or the other of the system. It is therefore recommended that some effort be made to keep the load fairly well divided between each of the two outside wires and the neutral.

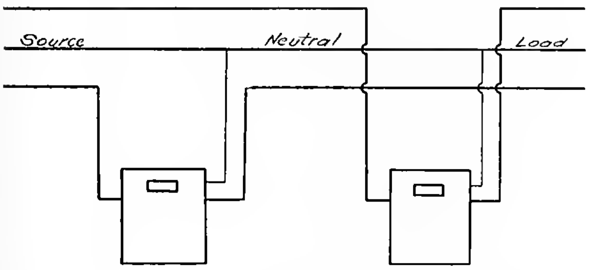


Fig. 48.

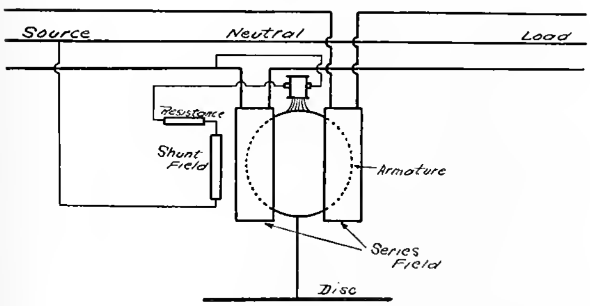


Fig. 49.

To measure the power flowing in a three-wire system, it is necessary to use two meters connected as shown in Fig. 48, or to use one three-wire meter whose internal connections are shown diagramatically in Fig. 49. The only way in which the three-wire meter differs from the ordinary two-wire meter is that in the former the series field coils are divided into two equal sections, which are connected in the opposite sides of the system as shown above.

There are devices on the market for automatically connecting the potential circuit to the opposite side of the line without reversing the direction of rotation of the meter in case one side of the three supply wires should be disconnected.

The armature circuit is usually connected between the neutral and one of the outside wires in the three-wire meters, because such practice permits cheaper construction, due to the lower voltage impressed. (In Fig. 50, P represents the armature circuit and FF the series field coils.) In either case—that is, with the armature circuit across the outside wires or across one outside wire and the neutral—the three-wire meter is subject to error on unbalanced loads; if connected to neutral it may register either slow or fast, depending upon whether the voltage between C and B (Fig. 50) is less than or greater than one-half the voltage between A and B. If the potential circuit is tapped from A and B, the meter will usually register high on unbalanced voltage, as the lower voltage will usually be on the heavier loaded side. It is very seldom that the unbalancing of the load on a three-wire system is such that it will cause any great degree of inaccuracy, but if extreme accuracy is a question of prime importance it is recommended that two two-wire meters be used rather than one three-wire meter on poorly balanced system.

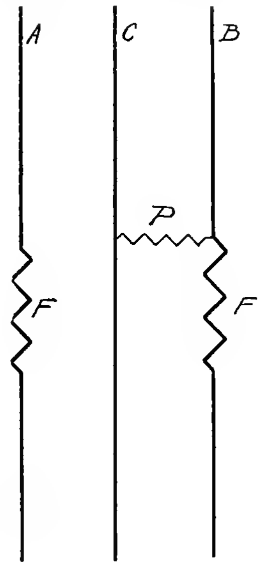


Fig. 50.

High Capacity Meters for Switchboard Service.

In order that the distributing company may have an exact comparison between the power actually delivered from the station bus-bars and the delivered power from which a revenue is realized, it is of the utmost importance that switchboard meters be carefully selected as to their accuracy and their capacity. The question of "over-metering" as brought out in Chapter I applies with even more force in the case of switchboard meters—the detection of unwarrantable losses depends primarily upon the switchboard meters. It will be found in almost every case that it is more desirable, for several reasons, to use individual meters on the various generators or feeders than to use "total-output" meters. In the first place, if a single meter is used, its capacity will have to be greatly in excess of the average load, in order that it may take care of the "peak" load, consequently the large meter will be running far below its maximum efficiency the greater part of the time. Secondly, if it is desired at any time to increase the capacity of the

station, the individual method of metering will be found to be much more flexible than will the total output meter method. In the third place, it is much more convenient to test the smaller, individual meters, on account of their lighter connections and the ease with which testing instruments may be inserted in the circuits. All switchboard meters should be so installed that future testing may be done with the least possible trouble and inconvenience.

High capacity meters for direct current switchboard service are, in almost every case, subjected to the influence of powerful stray fields produced by the bus-bars which are usually in close proximity to the meters; short-circuits and overloads also give rise to disturbing influences. In order that switchboard meters be free from such disturbances, special construction is necessary. Fig. 51 is an example of a

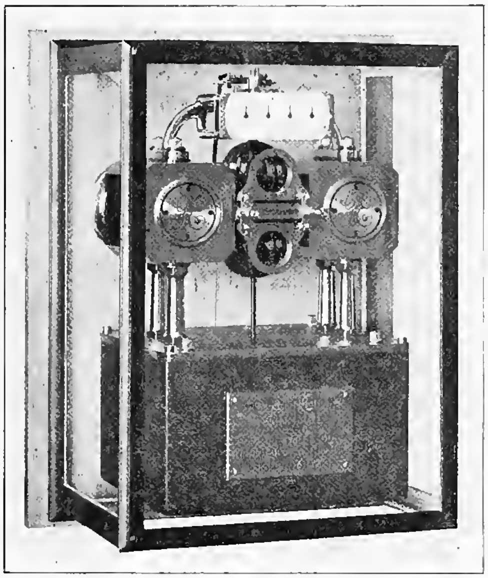


Fig. 51.

high capacity meter, the one illustrated being for 3000 amperes. The two armatures are "astatically" arranged—that is, they are so connected that should the influence of a stray field tend to weaken the torque of one armature, it will correspondingly strengthen the other, and vice versa. It will also be noticed that the retarding magnets are completely shielded by a rectangular metal box which is built up of soft steel punchings, which will effectually divert any stray lines of magnetic force which would otherwise affect the accuracy of the meter. Very often it is found necessary to place such a shield on a meter after it has been installed, after which it will also be necessary to recalibrate the meter, because the close proximity of the shield to the retarding magnets will cause a leakage of flux, thereby decreasing the retardation of the magnets. This effect is usually slight, but it is always better to recalibrate the meter.

The series field coils of the meter shown in Fig. 51 are of the "bus-bar" type, the magnetic field being produced by a straight copper bar which carries the current from one of the large studs past the armature to the other stud, the effect being that of a single turn. The standard sizes of this type range from 2000 to 10,000 amperes at potentials from 100 to 600 volts inclusive.

Switchboard watthour meters ranging in current from 50 to 1500 amperes have the same astatic features as above noted, but instead of having the "bus-bar" field coil, they have several turns of heavy copper. Their damping system should also be encased in a protecting steel box when the meter is in the neighborhood of conductors carrying large currents.

Another difference between the switchboard type of meter and the ordinary house type is that in the former, all resistance in series with the armature or the compensating field is usually external to the meter case, thus minimizing the heating effect from this source.

In selecting a switchboard meter, the following points should be borne in mind: The meter should have a high torque, continued high accuracy, light weight of moving element, and should have its armatures and retarding magnets astatically arranged.

A recent development has been made in the design of switchboard meters which further protects it against the disturbing influence of stray fields. This is accomplished by making the "motor" a four-pole rather than a two-pole motor. By this arrangement it is possible to place two adjacent (positive and negative) poles much closer together than in the case of the two-pole design. It will therefore be readily seen that a stray field coming from any direction will tend to more equally strengthen one pole and correspondingly weaken the other, than in the case of a two-pole meter.

This type of meter can of course be used for ordinary service as well as for switchboard service, provided the conditions warrant the expense of the four-pole meter.

Connections of Commutating Type Meters.

The connections of the commutating type of watthour meters when used on direct current circuits are so simple that it is not deemed necessary to give but a few characteristic connections which are shown in the following figures:

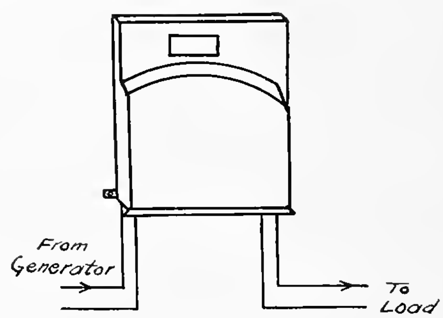


Fig. 52.

Fig. 52 shows the connections of a small capacity (3 to 50 amps.) two-wire "T. R. W." meter, of which there are still quite a number in service. Fig. 53 is the same type meter for two-wire service in capacities of from 75 to 1200 amperes. Fig 54 is the "T. R. W." three-wire, 3½ to 150 ampere meter.

Fig. 55 shows the connections of the General Electric type "C" watthour meter for

5 to 25 amperes, 500/600 volts, 2 wire (C-6 and C-7)

50 amperes, 100/250 volts, 2 wire (C-6).

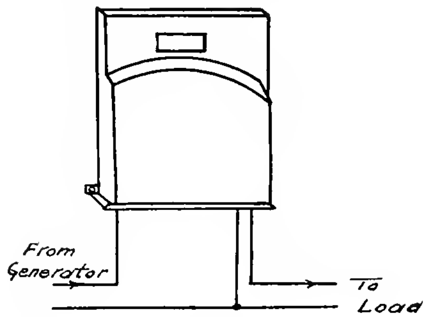


Fig. 53.

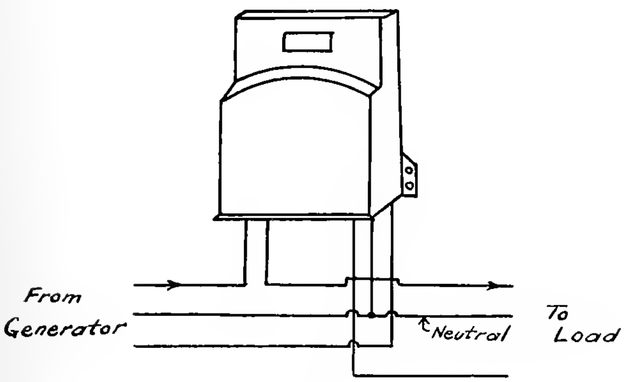


Fig. 54.

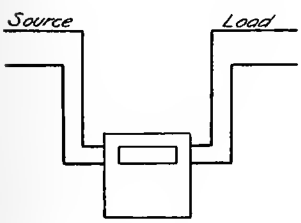


Fig. 55.

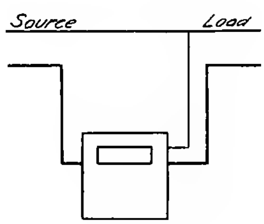


Fig. 56.

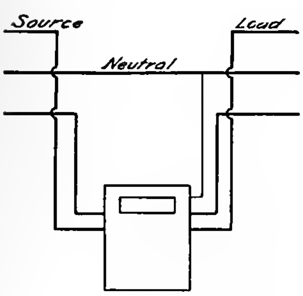


Fig. 57.

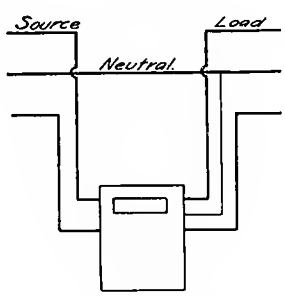


Fig. 58.

Fig 56 is the connection of a General Electric type "C":

75 to 600 amperes, 100/250 volts, 2 wire (C-6 and C-7).

50 to 600 amperes, 250/600 volts, 2 wire (C-7).

It will be noticed that in Fig. 56 that only one line wire is carried through the meter on account of the large size of the conductors.

Fig. 57 shows connections of a General Electric type "C":

5 to 50 amperes, 200/240 volts, 3-wire meter.

Fig. 58 shows connections of a General Electric type "C":

75 to 300 amperes, 200/240 volts, 3-wire meter.

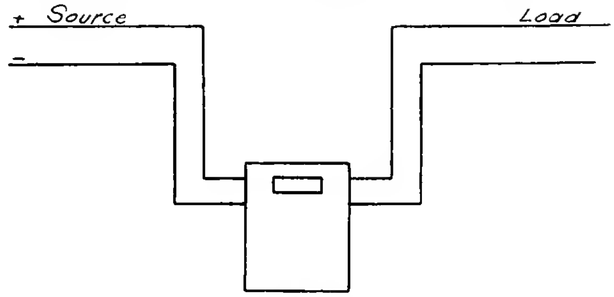


Fig. 59.

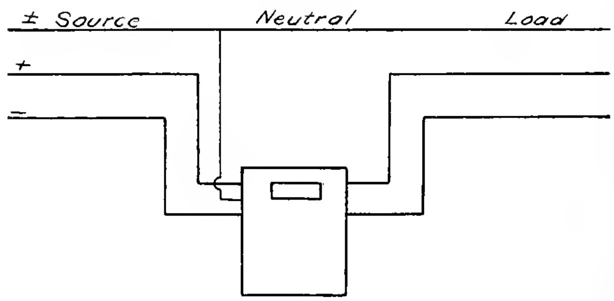


Fig. 60.

Figs. 59 and 60 show connections of the Westinghouse two-wire and three-wire direct-current meters, respectively.

(To be Continued.)

CARBIDE OF CALCIUM.

The severe crisis in the carbide industry on the European continent, according to the Electrical Review of London, has now lasted for a period of two years, and has become so intense that various German and other works have been compelled to suspend production, whilst others are declared to be conducted at a loss. A solution of the problem is, however, thought to be possible by forming an international syndicate. Various works equipped themselves for the contest some time ago, and intended to continue the fight to the bitter end. But owing to the large losses, and perhaps also to the pressure of bank connections, these works have gradually assumed a more conciliatory tone, and it is said that secret negotiations in regard to a syndicate have been opened with the Italian producers.

BANQUET TO C. A. COFFIN.

C. A. Coffin of New York City, president of the General Electric Company, was the guest of honor at a dinner given him on the evening of April 6th at the Fairmont Hotel in San Francisco by Dr. Thomas Addison, Pacific Coast manager of the company, Dr. Addison acting as toastmaster. Speeches of congratulation on the success of the company on this Coast, and particularly in California, were made by Garret McEnerney, Thornwell Mullally, Virgil Bogue, Mortimer Fleishhacker, I. W. Hellman Jr., Charles C. Moore, Frank B. Anderson and C. L. Cory.

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Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

The announcement that it is now possible to produce ductile metallic tungsten in the electric furnace means much for the tungsten lamp which has heretofore been hampered by its filament fragility. Under present methods of manufacture tungsten particles have been welded into a continuous filament by passing an electric current through a binding material containing the metallic particles and driven off by the high heat. By this new method the metallic tungsten can be drawn into fine wire much stronger and more rugged than the sintered filament. It is expected that the incandescent lamp made with these new filaments will not only have a longer life but also be even more efficient than the present tungsten lamps.

The Success of a Failure

Western America is a land of romance. Here Nature has invariably combined the beautiful with the wonderful. This she has done in limitless variety, for her resources seem to be infinite. Whether it be vast ranges of mountains interspersed with huge canyons, great expanses of desert, or lovely valleys luxuriant in their verdure, her handiwork is never mediocre, it is sublime.

The pioneers who have had the development of this country in their keeping, seem to have caught this bold spirit, for from our earliest knowledge they have been inspired to great accomplishments. And human endeavor has been closely entwined with Nature and her wonders.

There is nothing commonplace in the history of the past half-century or more. Life in the West and the growth of civilization have not been mere copies of other older communities. Man's accomplishments here will ever stand as the result of unusual opportunity, untiring effort, and the irresistible intermingling of the wonderful spirit of Nature.

The invasion of the padres and the founding of their missions, can never be forgotten; their peaceful influence has imparted a noble charm to their communities; the hostility and treachery of the redskin, on the one hand, and their teaching of simple methods of living, on mountain and desert, on the other, have implanted rugged character; the discovery of gold has moulded the destinies of the people, while the wonderful growth of the cultivation of fruit and flowers, through irrigation and, finally, the harnessing of the natural resources, in the development and transmission of power, have placed the Westernland on a pedestal before the eyes of the world. All of these things belong to the West, all represent the courage, persistence and nerve of the hardiest blood of the nation.

But developments did not come singly, one was the natural result of another. Power from the mountain waterfalls was utilized to operate the quartz mill and this water was afterwards distributed over the land to supply the one great element, necessary to make it produce, the one thing that Nature had forgotten. The daring of some of the earlier projects was little short of astounding and seemed to prove that man had been infected with Nature's inspiration for great things and would attempt to outdo her, and not the least of these was that of bending the course of the Feather river in California to man's will.

When the commercial science of transmitting electricity in quantity was given to the world, and the possibility of sending power great distances by means other than mechanical, it was the West that was first to embrace the opportunity.

Cheap power meant the building up of industries; it was needed where it could not be had. The older developments pointed the way. Many of the earlier transmissions were dependent upon and made possible by the already existing mining canals and irrigation ditches, and a new source of wealth was inaugurated.

Most thrilling is the story of how failure was turned to success and a miner's shattered dream materialized in the development of the Great Western Power Company.

PERSONALS.

Henry Frosch of San Francisco is at Coronado Beach, in Southern California.

K. G. Dunn, engineer with Hunt, Mirk & Co., of San Francisco, is in Seattle.

H. V. Carter has returned to San Francisco after spending a few days in Los Angeles.

Jedd P. Fuller, publisher of the Pacific Builder and Engineer of Seattle, is in San Francisco.

A. L. Menzin has resigned as engineer for the Tracy Engineering Company of San Francisco, to go East.

Leon M. Hall, consulting electrical engineer for the Comstock mines, has been visiting the plants at Virginia City.

Frank H. Short of Fresno, who is attorney for extensive water-power and lighting interests of Southern California, is in San Francisco.

William A. Hillebrand has been promoted from instructor to assistant professor of electrical engineering at Leland Stanford Jr. University.

R. S. Chapman, representing the H. M. Byllesby interests in California, recently returned to San Francisco after making a trip to the North.

C. J. Winslow, formerly with the Holabird-Reynolds Electric Company, is now sales manager for Brooks-Follis Company of San Francisco.

J. S. Baker, who has charge of the small motor department of the General Electric Company, has been spending the past week in Los Angeles.

C. R. Downs, manager of the Amador Electric Light & Power Company, of Sutter Creek. was a visitor in San Francisco during the past week.

J. O. Toby has been appointed superintendent of the Sacramento Electrical Division of the Pacific Gas & Electric Company, succeeding W. C. J. Finely.

Francis Hodgkinson, head of the steam turbine department of the Westinghouse Machine Company, has left San Francisco for Pittsburg, via Los Angeles.

H. A. Tedford, superintendent of construction for the Northern California Power Company, with headquarters at the Volta Station, recently spent a few days in San Francisco.

S. N. Griffith of Fresno, who was formerly at the head of the Fresno Traction Company, and is now interested in oil wells, was a San Francisco visitor during the past week.

D. A. Lyons expects to start the electric furnace of the Noble Electric Steel Company at Herault, Cal., April 11th, after a slight delay caused by waiting for a carload of large electrodes.

W. H. Leffingwell, engineer of the Mono Power Company, with headquarters at Bishop, Cal., was in San Francisco during the past week on business connected with the Owens river development.

Elmer M. Van Frank, president of the Petaluma-Santa Rosa Railway, was married April 4th to Miss Anna C. Glalin of Petaluma. The happy couple have gone on a honeymoon trip to Rialto, where Mr. Van Frank owns an orange grove.

Henry G. Stott, superintendent of motive power for the Interborough R. T. Co. of New York City, is expected in Los Angeles this month in connection with the new steam-turbine equipment of the Redondo plant of the Pacific Light & Power Company.

S. B. Gregory has been appointed Pacific Coast manager for the Arrow Electric Company of Hartford, Connecticut. Salesrooms and offices have been opened at 629 Howard street, San Francisco, with a complete line of Arrow E sockets and switches.

E. V. D. Johnson general manager of the Northern California Power Company, has returned to Redding, after conferring with President Noble at the San Francisco office regarding the new contracts that are to be let for the second installation on Battle Creek.

C. A. Coffin, president of the General Electric Company, who has been making an automobile tour of Southern California, spent the past week in San Francisco with his family. After looking over his interests in the northern part of the State Mr. Coffin will visit the Pacific Northwest.

H. H. Jones, former manager of the Springfield (Ill.) Street Railway, Gas and Electric Company, has recently been appointed manager of the San Diego Gas and Electric Company, of San Diego, Cal. Mr. Jones succeeds C. E. Groesbeck who has been promoted to district manager of the Pacific Coast plants of H. M. Byllesby & Co.

A. W. Ballard, who has for the last twenty years been connected with the General Electric Company, and who is now its Los Angeles manager, has resigned his position to take effect May 1, 1910. Mr. Ballard is going to spend a few months traveling, and after he feels that he has had sufficient rest, will again take up his residence in Los Angeles and will spend his time looking after his own interests.

C. E. Groesbeck, who has been manager of the San Diego Consolidated Gas & Electric Co., recently passed through San Francisco on his return from a trip to Portland in connection with taking charge of H. M. Byllesby & Co.'s offices in that city. A suite of seven rooms in the Lewis Building are now occupied. Mr. Groesbeck, as vice-president of H. M. Byllesby & Co., stated that $5,000,000 will be expended on betterments of the Northwestern gas, electric and telephone systems that have been acquired, and that further purchases will be made.

H. H. Noble, president of the Northern California Power Company, has returned from an inspection of his power transmission lines in Shasta County. It is understood that contracts will be closed without further delay for the electrical equipment for the new power development at Horseshoe Bend, on Battle Creek. Three 4,000-k. w. units will be installed this season, utilizing an effective head of 440 feet of water. This will increase the total capacity of the Northern California Power Company's system to 42,000 h. p., divided between five power stations.

LOS ANGELES ELECTRIC SHOW.

A committee of seven has been appointed by the Los Angeles Sons of Jove to investigate the possibilities of an electric show in Los Angeles. The committee have not, as yet, made their final report and until they do so no definite action will be taken. It is very favorably looked upon, however, by nearly all of the local concerns and a great deal of enthusiasm has been shown, which is a very encouraging feature.

LOS ANGELES MEETING OF ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.

On account of the reduced railroad rates to Los Angeles during the month of June, 1910, and in order that associate members and friends who will be required to pay their fares, may take advantage of the lower rates, it has been decided to postpone the annual convention of the Railway Telegraph Superintendents' Association, which is to be held at Los Angeles, to June 20-25, 1910. Headquarters are to be established at the Alexandria Hotel.

This postponement promises to make it convenient for a number of active members also, who would be unable to leave their business during the month of May, to attend the convention; therefore, it is believed that the attendance will be largely increased by the action taken.

CHANGE IN DATE OF INSTITUTE MEETING AT SAN FRANCISCO.

Circumstances have made it expedient to change the date of the proposed meeting at San Francisco, from April 21-23 to May 5, 6 and 7, 1910. The meeting will be under the auspices of the High-Tension Transmission Committee, and will be held in the auditorium of the Home Telephone Company's building, 333 Grant avenue, San Francisco, Cal. There will be four professional sessions on the first two days, and a tour of inspection on the third day and several days of the succeeding week. The sessions will be held at 9 a. m. and 2 p. m. on May 5 and May 6, 1910. The following papers will be presented:

"The Developed High-Tension Network of a General Power System," by Paul M. Downing, engineer of operation and maintenance, Pacific Gas and Electric Company.

"Hydroelectric Developments and Irrigation," by John Coffee Hays, consulting engineer, and president, Mt. Whitney Power Company.

"Emergency Generating Stations for Service in Connection With Hydroelectric Transmission Plants Under Pacific Coast Conditions," by A. M. Hunt, consulting engineer and past-chairman, San Francisco Section A. I. E. E.

Through the courtesy of the several central California hydroelectric power companies, arrangements are being made for convenient visits to the more important nearby plants and receiving stations in the San Francisco Bay region on Saturday, May 7th, and to the transmission plants and mountain generating stations the first days of the succeeding week.

The high character of the papers which will be presented at this meeting, as well as the valuable discussion to be expected, should attract a large number of engineers, not only from the Pacific Coast, but from other parts of the country. It is earnestly hoped that a representative attendance of the Institute membership will be present and participate in this meeting.

The opportunities afforded by the proposed tours for observing high-tension transmission practice in central California will add greatly to the interest.

The program has not as yet been fully completed, and Mr. Ralph D. Mershon, 60 Wall street, New York City, chairman of the High-Tension Transmission Committee; Professor Harris J. Ryan, the California member of that committee, Stanford University, Cal., and Mr. S. J. Lisberger, secretary of the San Francisco Section, 445 Sutter street, San Francisco, will cheerfully respond to all requests for additional information.

At a recent meeting of the San Francisco Section the following resolution was passed:

"The secretary of the local section is instructed to publish in the next issue of the Journal of Electricity, Power and Gas a notice to the effect that the postponement of the meeting of the High-Tension Transmission Committee of the Institute, which was to have been held on April 21st, was done by the Transmission Committee, and not as an act of the local section or of its officers."

TRADE NOTES.

The Brown Electric Company of Wenatchee, Wash., has closed contracts for a 5000-h.p. development on the Entiat River, 20 miles from Wenatchee. This involves the construction of a dam 425 ft. in length and 28 ft. in height.

The Engineering & Maintenance Company, representing the Crocker-Wheeler Company in San Francisco, has just closed a contract to install for the Hicks-Judd Company in their new printing office, on First street, 30 Crocker-Wheeler direct-current motors, ranging from ¼-h. p. to 5-h. p. The presses are to have individual motors with the latest Carpenter-type controllers. Hampton automatic roller racks will also be installed.

A. J. Bowie Jr. of San Francisco has taken a contract for a number of high-tension switches, of a type that he invented, which are to be tried out at 110,000 volts on the Stanislaus transmission line of the Sierra & San Francisco Power Company.

The Crocker-Wheeler Company's agents are preparing to install a 25-h. p. direct-current motor to drive a 20-page press for the "Sun," a new San Francisco daily paper, on Mission street, between First and Second. Each stereotype machine will be equipped with an individual Crocker-Wheeler motor.

The General Electric Company has sold the Northern California Power Company a rotary condenser, which will be installed on their extensive system for the purpose of bringing up the power factor on some of the lines. The machine is rated: A. T. I. 10-1,000 k. v. a 720 r. p. m. 2,300 v. It consists, practically, of a synchronous motor with a "squirrel cage" in place of the ordinary winding.

The rapid growth of H. M. Byllesby & Co., of Chicago, and the constantly increasing number of cities and towns in which it owns, operates and manages utility properties, has caused the company to open a department of publicity. The new department will handle both the commercial and educational advertising of the organization, and will be in charge of William H. Hodge. Mr. Hodge formerly was managing editor of the monthly magazine, Public Service, and is a specialist in publicity work for utility companies.

The General Electric Company has sold the Great Western Power Company one 4-unit, 4-bearing frequency changer set, as follows: An A. T. B. 10, 2500-kw., 300 r.p.m., 13,200-v., 25-cycle generator, driven by an A. T. I. 24, 2750-kw., 300 r.p.m., 11,000-v., synchronous motor, with direct-connected exciter and starting motor. A T. 29 D controller will be used. Twenty-five cycle current will be supplied to the Southern Pacific Company's rotaries, which will furnish current for the operation of their local electric roads in Alameda County.

Sanderson & Porter report good progress on the equipment of the Sierra & San Francisco Power Company's Bay Shore substation. All of the 3750-kw. tansformers have been dried out ready for service as soon as the transmission line and switchboard are completed. Eight construction crews are pushing the line work and it is probable that the United Railroads will be able to take power from the Stanislaus plant within a month. One of the new 1500-kw. General Electric motor generator sets in the Bryant avenue substation is already in successful operation, using a connection from the present source of supply.

The city of Cannon Falls, Minnesota, has recently awarded the Pelton Water Wheel Company contract for two main 750-h.p. Pelton-Francis turbines and one 60-h.p. Pelton-Francis turbine for driving the exciter. The main turbine as well as the turbine for driving the exciter will be direct connected to electric alternators and supply current for the municipal lighting service besides current for the commercial power load.

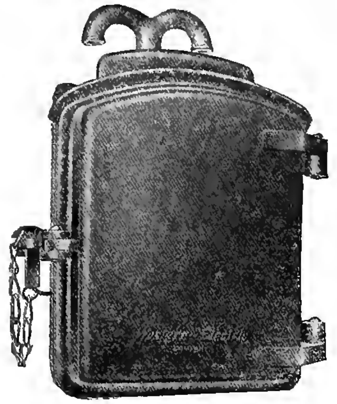
Additional turbine contracts to be awarded the New York works of the Pelton Water Wheel Company is the AuTrain power plant, AuTrain, Wisconsin; besides large turbines for the firm of H. M. Byllesby & Co. of Chicago.

The contract for the new exchange at Dickenson, N. D., has been awarded to the Kellogg Switchboard & Supply Company, Chicago. The new switchboard is to consist of two 1,800-line sections with the following equipments: 540 common battery multiple lines, ten toll lines, twenty pay station lines. tI is to have three common battery positions and one toll position, also, one toll test panel equipped for ten lines. The power equipment will consist of two sets of cells storage battery, one mercury arc rectifier, two Kellogg four frequency pole changers and two sets of transformers in one cabinet. There will be a Monson slate power board to match rectifiers.

INDUSTRIAL

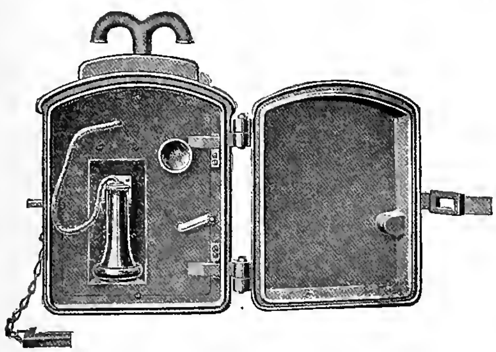
NEW MINE TELEPHONES.

The Western Electric Company announces the completion of the design of two new types of mine telephones, on which its engineers have been at work for the past eighteen



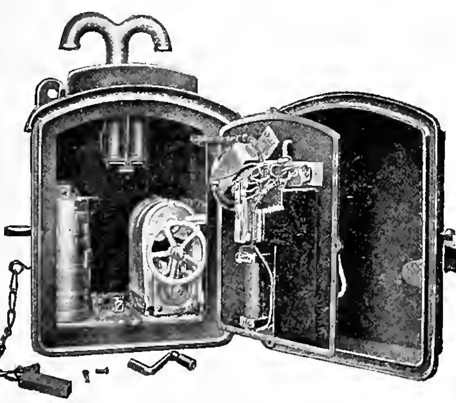
Mine Telephone. Metal Type, Closed.

months. The accompanying cuts illustrate three views of the new No. 336-E metal type set. A specially treated wooden type set has been developed, having the same general features of operation and arrangement as the metal set shown here.



Mine Telephone. Metal Type. Open for Use.

As it will be noted from the cuts, the sets are very compact and most attractively designed. All of the apparatus inside the case is most accessibly arranged, but at the same time it is carefully protected. All maintenance work in connection with

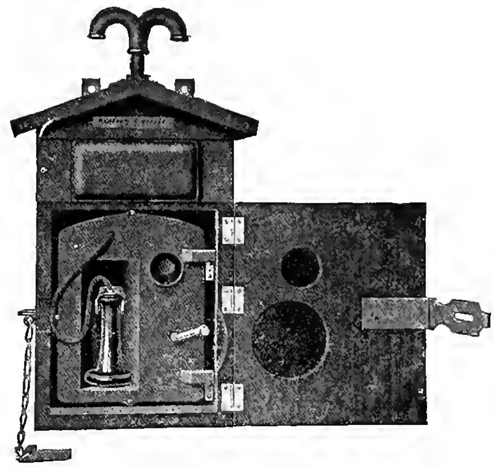


Mine Telephone. Metal Type. Open for Iespection.

these sets can be attended to simply through the use of a screw-driver. No soldering irons or torches are necessary.

The line wires to the sets may be brought in either at the top of the box or at the bottom. When brought in at the top the curved connector shown at the top of the box in the illustrations is used. This connector, it will be noted, prevents moisture or water from running into the set when the wires are led into the top of it. It will be readily seen as the wires come down to the set and make the turn into the curved connector any moisture or water will drop from this point and not follow the wire into the apparatus.

When the line wires are brought in from the bottom it is not necessary to use the curved connector, and the opening for it at the top of the set is closed by a suitable plug provided for the purpose.



Mine Telephone. Wooden Type.

The gongs are specially designed to give a loud, clear ring which can be heard a long distance in the mine. As seen in the illustration, these gongs are protected by a hood, making it impossible for large particles of foreign matter to fall on them or interfere in any way with their action.

The sets are equipped with a No. 48 type 5-magnet generator, which is the most efficient hand generator for telephone use on the market. The transmitters and receivers are of the standard "Bell" grade type which are so well known in this country and abroad. All the windings of the receivers, ringers induction coils and generators are specially treated so as to protect them from the acid fumes, gases and moisture.

NEW CATALOGUES.

The rapid increase in the use of concrete has necessitated a corresponding increase in the manufacture of Portland cement. Bulletin No. 4722, recently issued by the General Electric Company, enters more or less into the details of electric drive in connection with the manufacture of this material, pointing out the advantages, offering suggestions to millowners, and illustrating a number of installations.

The General Electric Company has recently issued a publication devoted to the use of the flame arc lamp for the lighting of streets and large interiors. The high efficiency of the flame arc lamp is well known. The lamps described in this publication are designed to operate two in series on 110 v., alternating or direct current; four in series on 220 v., alternating or direct current; ten in series on 550 v., alternating or direct current; direct current series 9 6-10 amperes, alternating current series 4 to 7 5-10 amperes. The descriptions of various lamps are taken up in detail and will prove of interest to central station men. The number of this bulletin is 4717.

NEWS NOTES

FINANCIAL.

RED BLUFF, CAL.—The Victoria Power and Mining Company, which operates mines at French Gulch, has increased its stock from 150,000 to 250,000 shares, at the par value of $1 each.

THE DALLES, ORE.—The City Council has passed a resolution calling for putting before the people at the next election the bonding of the city for $5,000 for the purpose of refunding certain water bonds, to run for 10 years, to bear interest at 6 per cent.

SACRAMENTO, CAL.—A clear water supply for Sacramento lost out when the $666,000 bond issue for a filtration plant and pumping station was defeated at the polls by 176 1-3 votes. The total of 4,109 votes were cast. Of this number 2,563 favored the bonds and 1,546 were opposed. It took a two-thirds vote, or 2,739 1-3 votes, to carry. The principal opposition rested with the brewery interests, which were solidly opposed to the bonds.

INCORPORATIONS.

SEATTLE, WASH.—The Berlin Power Company has been incorporated with a capital of $500,000 by R. C. Burtraud, F. L. Forbes and Jas. H. Henley.

OREGON CITY, ORE.—The Home Oil and Gas Company, with a capital stock of $25,000, has been incorporated by L. Vierhus, J. Mumpower and J. W. Watts.

ROSEBURG, CAL.—The Roseburg Oil and Gas Company, with a capital stock of $10,000, has been incorporated by F. W. Dillard, G. A. Harmon and J. T. Goodman.

PORTLAND, ORE.—The Central Oregon Water Power Company, with a capital stock of $500,000, has been incorporated by H. F. Chapin, A. G. Hill and N. B. Chapman.

VISALIA, CAL.—The Gibson Addition Water Company of Lindsay, with a capital stock of $1,600, has been incorporated by W. H. Amdock of Visalia, E. J. Yarnall and L. W. McClellan of Lindsay.

SEATTLE, WASH.—The Waupello Corporation, with a capital of $100,000 has been formed by Andrew P. Johnson, Charles Eugene Banks and J. F. Roy Erford, to develop light and water power.

TACOMA, WASH.—Evans-Dickson Company of Tacoma, Wash. (electrical equipment, telephone, telegraph, etc.), with a capital stock of $20 000, has been incorporated by Llewellyn Evans and D. T. Dickson.

TACOMA, WASH.—Articles of incorporation have been filed for the Thomas Gas Light & Power Company, with a capital stock of $2,000,000. The trustees are: R. Thomas, San Francisco; F. A. Schmallo, Tacoma; A. M. Holton, San Francisco, and D. D. Schneider, Tacoma.

PORT ANGELES, WASH. — The Olympic Power & Electric Company has been incorporated with a capital stock of $1,000,000. The incorporators, Geo. A. Glines and Thomas T. Aldwell, formed this company for the purpose of developing the power on the Elwha River. Engineer E. W. Cummings will have charge of the engineering and development work.

ELLENSBURG WASH.—Articles of incorporation have been filed by the South End Water Company, capitalized at $12,000 and with its principal place of business in this city. Its objects are to construct and operate and renew a system for the supply of water to such parts of Ellensburg as it shall obtain franchise for; also to purchase, own and sell shares of other water companies. The incorporators are: G. DeWees, C. Anderson and J. W. Gilliam.

TRANSMISSION.

SPOKANE, WASH.—Boulevard Park Railway Company has been incorporated for $12,000 by Samuel Glasgow et al.

WENATCHEE, WASH.—The Wenatchee Valley Railway & Power Company has been granted a street-car franchise here.

EPHRATA, WASH.—A 45-year franchise was recently granted L. V. Wells for furnishing light aud power for this place.

EUGENE, ORE.—The Lane County Asset Company will soon begin the surveys for its electric lines in this place and vicinity.

IONE, WASH.—The $6,000 dam of the Ione Light & Power Company across Cedar Creek at this place has been washed out.

TACOMA, WASH.—The Puget Sound Power Company has been granted a franchise to erect a line of poles along the county road from Electron to Kapowsin.

BAKERSFIELD, CAL.—The San Joaquin Light & Power Company will complete its transmission line, about April 10th, from Lemoore to Coalinga, 40 miles No. 2 copper, 30,000 volts.

MISSOULA, MONT.—The Chamber of Commerce is negotiating with W. H. Smead of this city for the construction of an electric railway 75 miles long between this place and Polson.

TENINO, WASH.—The Tenino Light & Power Company is making ready to begin work on a $200,000 power plant on the Skookumchuck this spring. S. W. Fenton is president of the company.

GRANGEVILLE, IDAHO.—A 30-year light and power franchise has been granted to Walter Hovey Hill and work on the power plant about five miles from here on the South Fork will be started at once.

VANCOUVER, B. C.—It is announced that the Dominion authorities have given the Vancouver Power Company the right to construct the high dam and otherwise improve its hydraulic plant at Lake Coquitlan.

NEWPORT, WASH.—Henry Miner and J. C. Grover will soon begin development work on their proposed water power plant at Freeman Lake. Manufacturing plants are to be established for utilizing the power.

WENATCHEE, WASH.—The Brown Electric Company will open bids early in April for the construction of hydroelectric plant on the Entiat River to cost approximately $500,000, and to develop 5,000 h. p.

CALDWELL, IDAHO.—Harold Williams, City engineer, has started on a preliminary survey from this place to Roswell for an electric line which has been under consideration by the citizens of this place and vicinity for some time.

VICTORIA, B. C.—The West Coast Power Company, Ltd., through Lorenzo Alexander, one of its directors, is giving notice of an application for 3,500 ft. per second of water in Gordon River for the purpose of installing a fully equipped power plant.

VANCOUVER, B. C.—The route for the proposed tram line to Point Grey has been settled and the British Columbia Electric Railway will soon begin work on same.

COALINGA, CAL.—The Coalinga Electric & Water Company, Emery Weston manager, are scattering poles for distributing lines to oil fields. Have installed 300-kw. transformer Statem. Machinery for 600 kw., on way, will be installed immediately.

SEATTLE, WASH.—Captain J. L. Anderson, of the Anderson Steamboat Company, plans to build a railroad on the east side of Lake Washington, from near Bellevue to Redmond, by way of Kirkland. Gasoline cars are to be used at first and the line electrified later.

SEATTLE, WASH.—In addition to previous installations, the Superior Portland Cement Company, Seattle, Wash., has also placed an order with Allis-Chalmers Company for a 250 k. w. 3-phase, 60-cycle, 600-volt, 600 r. p. m. belt driven alternator and a 9 k. w. 120-volt exciter for the same.

CITY OF MEXICO.—Arrangements have been completed which places the Guanajnato Light and Power Company in possession of the electric company at San Louis Potosi. The new company will begin the operating of the San Louis plant some time during April. A transmission line will be built between two cities.

FRESNO, CAL.—An application has been made to the Board of Supervisors by the Fresno Traction Company, for a franchise of a street and interurban railroad along, across and upon certain streets and highways in the County of Fresno. Sealed bids will be received up to 11 a. m. April 23, 1910, for the sale of the franchise to the highest bidder.

SACRAMENTO, CAL.—Joseph Shaw has filed an application for a franchise to stretch wires along the county roads for the purpose of supplying electricity for light, power and heat. He is in the suburban field of Sacramento and wants a franchise particularly for Oak Park, Curtis Oaks, Highland Park and Oak Grove. The power will be furnished by the Great Western Power Company.

CHIHUAHUA MEX.—Reports from Ocampo are to the effect that the Sierra Consolidated Mines Duluth Company, headed by Thos. F. Cole, J. B. Cotton and R. M. Atwater Jr., is well pleased with the result of the development work on its Ocampo mines. It is understood that the company has decided to build an electric power plant in timber where wood is plentiful and transmit power to its mines and mill.

WEISER, IDAHO.—The Council Mesa Orchard Company, composed of Eastern capitalists who own about 20,000 acres of orchard land between Cambridge, Council and Indian Valley are contemplating the installing of an electric plant on the middle fork of Weiser, power to be generated from that stream, by which an electric line will be operated from the land of the company to a connection with the Pacific and Idaho Northern, at Goodrich, including a distance of 25 miles.

GRAYS HARBOR, WASH.—The growing competition for the acquisition of established electric power and lighting plants all over the Pacific Slope has become very interesting of late. The latest announcement is that of the purchase of the Grays Harbor Railway & Light Company, of Aberdeen, Wash., by the Sanderson & Porter interests. The price is unofficially stated as $2,000,000. Sanderson & Porter and associates, of New York, have already secured control of a dozen public utility corporations. The largest of these is the Grays Harbor Railway & Light Company, which has about 12 miles of local and interurban electric road connecting Aberdeen with Hoquiam. The new management will soon begin a 40-mile extension of the interurban line, giving Grays Harbor connection with the Puget Sound cities. The first point reached will be Montesano, the county seat of Chehalis County. The new line will terminate at Olympia, where connections will be made with Northern Pacific for Tacoma and Seattle.

TELEPHONE AND TELEGRAPH.

LOS ANGELES, CAL.—The Pacific Telephone & Telegraph Company will build a three-story building for operating purposes in the Wilshire District to cost, with equipment, $150,000.

SUSANVILLE, CAL.—The application of Wm. E. Hills for a franchise to erect a telephone and telegraph line along the county road, running from Susanville to the boundary line between Plumas and Lassen counties, has been read and submitted.

SAN FRANCISCO, CAL.—Vice-President and General Manager R. P. Schwerin of the Pacific Mail Steamship Company, now in New York, has closed a contract with the United Wireless Telegraph Company for the installation of wireless plants in all the trans-Pacific steamers of the company, according to information given out yesterday by the United Wireless officials. The Korea of the Mail line already has a wireless plant said to be the most powerful carried by any merchantman in the Pacific, and the success that has been attained by Operator S. A. Phelps on this boat has finally convinced General Manager Schwerin that it would be advantageous to install outfits on all the steamers.

ILLUMINATION.

EVERETT, WASH.—The Everett Gas Company will spend $300,000 in improving plant.

HILLSBORO, ORE.—E. H. Corbett has been granted a franchise for a new light and power plant in the city.

LOS ANGELES, CAL.—Ornamental lights are contemplated for Seventh street, from Boyle avenue to Hoover street, 3½ miles. Seventy-one per cent of the frontage has been signed.

MISSOULA, MONT.—The contract for furnishing combination electric and gas lighting fixtures for the court house was awarded to Cascade Gas & Electric Fixture Company for $2,749.50.

TACOMA, WASH.—Sealed bids have been received at the office of the Commissioner of Public Works for one automatic hand-operated oil switch of 66,000 volts, to be delivered f. o. b. South Tacoma, Wash.

MEDFORD, ORE.—J. R. Anderson has applied for a franchise to erect a gas plant. If granted, work will start at once. Tanks and pipes to the amount of $100,000 will be installed the first six months.

LOS ANGELES, CAL.—By the award of a contract to the Stacy Manufacturing Company of Cincinnati, the San Bernardino Valley Gas Company of Los Angeles (Pacific Light and Power Company) for $135,000 to build a gas plant of 2,000,000 cubic feet daily capacity at Colton, a number of Southern California towns will be improved in lighting. This plant will supply San Bernardino, Colton, Redlands, Riverside, Pomona and several other towns.

OAKLAND, CAL.—An application by the Central Oakland Light and Power Company for permission to lay conduits through the streets of the city has been granted by the Board of Public Works. Excavation work will be commenced by the company in a few days in Eighth street, between Broadway and Clay; Tenth street, between Broadway and Clay; Twelfth street, between Jefferson and Alice, and in San Pablo avenue, from Fourteenth street to Twentieth street.

OAKLAND, CAL.—The Oakland Gas and Light Company is preparing to spend a large amount of money in the reconstruction of its distributing system. Frank A. Leach Jr.,

PROFESSIONAL DIRECTORY

manager, says that the company has been supplying current in the congested business districts at 110 volts ever since the pressure was increased in the march of electrical progress from 54 volts, about ten years ago, but has been distributing at 220 volts in the residence sections and especially in the outlying districts. In the last year there have been great developments in the electrical world and the progress made in the high efficiency lamps and other apparatus has been such that the company has decided to make such changes as will be necessary to supply its consumers with 110 volts in all but the scattered and outlying districts, where the great cost makes it prohibitive. High efficiency lamps are made for the higher voltage, but not in such variety as the lower voltage, so that all may use the new lamps if they desire.

TRANSPORTATION.

STOCKTON, CAL.—The application of the Stockton Terminal & Eastern Railway for a franchise over the road connecting the Waterloo road and East street, has been granted.

SACRAMENTO, CAL.—The Supervisors have passed an ordinance granting to the Northern Electric Railway Company a franchise to erect a bridge over the river at the foot of M street.

ISLAND BAR, CAL.—The Great Western Power Company has decided to use electric power instead of compressed air in the operation of its aerial trams. Electric derricks are also to be installed.

ALBUQUERQUE, N. M.—The construction of the new Highland car line by the Citizens' Traction and Power Company will begin within a week, at the south end of the line, on South Edith street.

PASADENA, CAL.—As one of the features of the four-track system between Los Angeles and Pasadena, now being constructed by the Pacific Electric, a double track will be laid on South Lake avenue.

SCIO, ORE.—Dr. A. G. Prill and E. C. Peery, promoters of the Scio-Munkers Railway project, have made application to the county court for a franchise for crossing the county road by an electric line to run from Scio to Munkers.

OAKLAND, CAL.—Because of a miscalculation in the time for the publication of the opening of bids for granting a street-car franchise to the Peninsular Railway Company, all bids were rejected by the Council, and sealed bids will now be received on May 2d.

THE DALLES, ORE.—The Council has passed an ordinance granting to E. W. Thomas, a Philadelphia capitalist, a franchise for the construction of a street railway line, to extend below and above the bluff, and to run southeast to the Dry Hollow District and southwest out Mill Creek way, and to be operated within two years.

CANANEA, MEX.—The ore-hauling system at the Four C.'s Mine, in the Cananea District of Mexico, will be electrified and transportation will be underground instead of over a narrow-gauge railway on the surface, as it is at present. It is expected to equip mines later with a system of underground electric railways, similar to that in use in the Bisbee Mines of the Copper Queen Company.

PORTLAND, ORE.—General Manager F. I. Fuller, of the Portland Railway, Light & Power Company, has announced that the railway company has decided to lay a double-track on Sandy road, from East Sixteenth to East Twenty-eighth streets, to be connected with the Burnside-street bridge, thus giving the Rose City Park the contiguous district, a much improved street-car service.

SAN FRANCISCO, CAL.—President Calhoun's latest report of the earnings of the United Railroads Company is for January last, when the company carried 12,563,320 passengers, or a little over 400,000 for each day of the month. This is 1,275,860 more passengers than were carried in January of 1909. Gross earnings for the month amounted to $627,666. This is an increase of $61,293 over the same month of last year, when the gross receipts were $566,373. Calhoun's report to the Eastern holding company of the local corporation on the month's business in all its various details is not made public, so the net earnings and surplus for the month cannot be given. The gross earning capacity and the number of passengers carried is considered a good and reliable comment on the growth and activity of San Francisco and its present population. The street railway officials are of the opinion that the January business of the company strongly indicates that the city easily has a population of 450,000.

SAN FRANCISCO, CAL.—The complete reorganization of the Vallejo, Benicia and Napa Valley Railroad Company, the electric line operating between Vallejo and Napa and St. Helena, is to be effected within a month's time. W. E. Botsford of Los Angeles will be eliminated from the management. Captain Z. J. Hatch, president of the Monticello Company, which now holds a strong traffic agreement with the electric road, declared that a reorganization was imminent and that the Monticello Company was considering the acquisition of the line, which is the natural feeder of the shipping company. Botsford is a Los Angeles financier, and the trustee of the bond issue is a Los Angeles trust company. The trouble in the corporation centered about Botsford's alleged handling of the recent $1,500,000 bond issue of the road. The Napa Valley electric road was started about five or six years ago. The original bond issue was $500,000. Several months ago a bond issue of $1,500,000 was projected for the double purpose of withdrawing the original bonds and spending $1,000,000 on an extension of the road to St. Helena. The extension has been made, but the $500,000 issue of bonds has not yet been retired to the satisfaction of the bondholders.

WATERWORKS.

OAKESDALE, WASH.—Sealed bids have been received by the Council of Oakesdale for the furnishing of the material and constructing of a system of waterworks.

BELLINGHAM, WASH.—Crane & Co. of Seattle were awarded the contract for the water department material called for in accordance with an order of the board some time ago.

SPOKANE, WASH.—J. F. O'Brien, secretary and manager of the Hanford Irrigation and Power Company, has announced that actual work on the irrigation project to irrigate 200,000 additional acres of land southeast of Spokane will be commenced this year.

BELLINGHAM, WASH.—The Board of County Commissioners have signed the franchise giving T. H. DeHaven, Dr. H. Thompson and M. F. Myers the right to install a water system in the town of Glacier. The water for the system will be secured from Cornell Creek, and the feed-pipe will be about 1,200 feet in length. Under the terms of the franchise two plugs must be installed on the main streets for fire protection.

SACRAMENTO, CAL.—An application was made to the Board of Supervisors, by the East Sacramento Water Company, for the grant of the right, privilege and franchise of laying and maintaining water pipes, mains and conduits in so many and in such parts of the public streets, highways streets and alleys as the grantee may elect in the portions of the County of Sacramento. Sealed bids will be received by the said board up to 2 p. m. April 22, 1910, for the sale of the franchise to the highest bidder.

INDEX TO ADVERTISEMENTS

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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FOR INDEX TO ADVERTISEMENTS SEE PAGE EIGHT

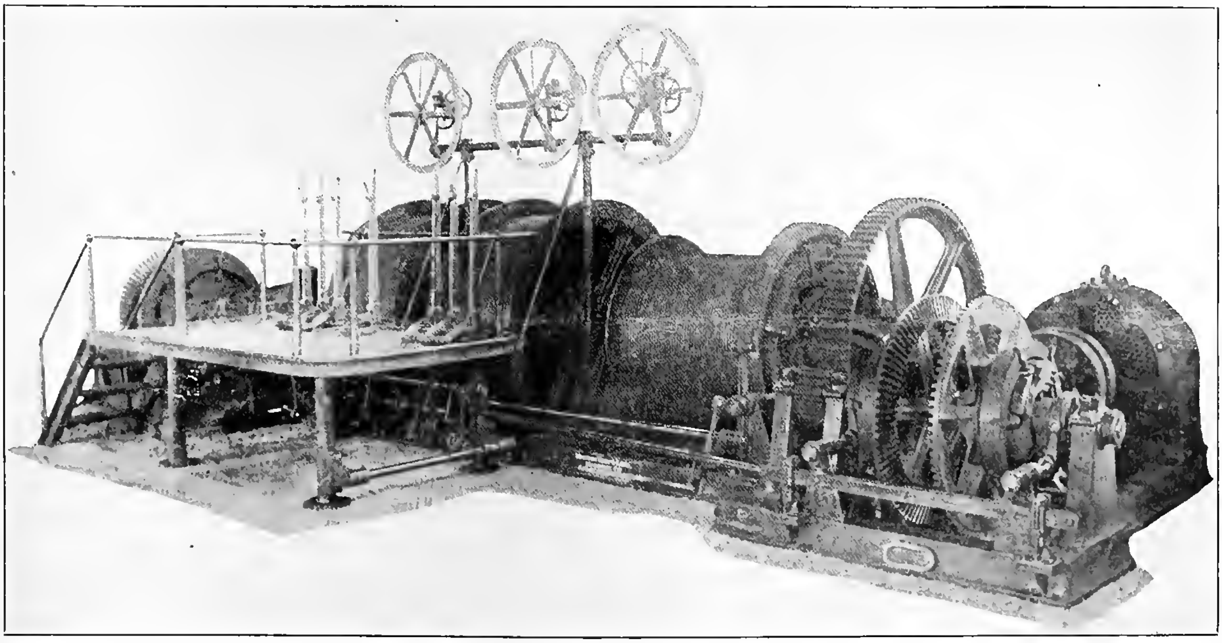
JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXIV — SAN FRANCISCO, APRIL 16, 1910. — NUMBER 16

ELECTRICAL EQUIPMENT FOR METAL MINES[1]

R. W. SHOEMAKER.

Not the least important of the economies effected by consolidating a number of neighboring mines under one management are those resulting from a similar centralization of power supply, especially if this power be electric. In one district, where there were numerous shafts, each with its individual equipment of steam boilers, steam pumps, hoists and air compressors, there is now one central station of gas-driven alternators, supplying energy for each class of power at an actual saving of thousands of dollars a month in operating expenses. In one instance, a boiler plant was maintained at a shaft for operating a steam reciprocating pump handling 450 gallons per minute, against a 400-ft. head. This equipment was replaced by a six-stage centrifugal pump, operated by a 200-h.p. variable-speed induction motor, with a resulting saving of a little over $400 per month. Electric power was furnished from a steam turbine station, which was not operating under the best of conditions or the saving might have been greater.



Three-Phase Induction Electric Hoist at Mercur, Utah.

Electric power, because of its convenience and economy, its flexibility and efficiency, its capability of transmission and its universality of application, is rapidly winning a place for itself in mining work.

Mining men are interested not in the generation but in the utilization of electricity; whether it is generated by steam, gas or hydraulic power is of little concern to them. But in its application there are certain problems which seem peculiar to mining work. Some of these have been successfully solved, others have not.

Among the latter are electric drills, of which the least said the better, for there seems to be no way yet commercially developed for obtaining the pecu-

[1]Paper read before Los Angeles Section, A. I. E. E., Feb. 25, 1910.

liarly effective blow of the drill by electric means. It is true there is an electric drill, so called, on the market that has some good points, but it employs air as the transmission medium between the piston of the drill and the electric motor. This machine has the disadvantage of being in two parts, that is the motor and modified air compressor and the drill proper, which have to be connected by two lines of hose of limited length. These restrictions reduce the usefulness of this drill in many localities, though in others and for special conditions, the extra weight and extra apparatus form no objection.

Powder firing by electric caps is the only safe way of sinking a shaft, and no other method should ever be used. A battery should be used in this work, as current from a power circuit is unreliable, either discharging one or more holes when one side only of the firing line is connected to the mains or shunting part of the string of holes through grounds in the connections at the fuses. In the shaft, firing wires should hang clear of every obstruction as far as possible, to remove all possibility of leaks with resulting dangerous misfires.

Electric Haulage.

After the ore is broken and loaded in cars, electric haulage next requires attention. In this work, regulation street railway practice can be followed, with a few exceptions. In the first place, owing to the necessity of using the same drifts as passageways for men, mules, and motors, it is desirable to set the trolley wire outside of the rail instead of in the center between the rails. It can be suspended either by span wires crossing the drift and carrying the regulation hanger and ear, or, where the back or roof of the drift permits, placing a hanger directly connected to an expansion bolt. Fastenings to rock walls are easily made by drilling a 1-in. hole about 8 in. deep and driving in a ⅞-in. bar with an eye on the outer end and a split end with wedge on the inside. The act of driving swells the end inside the hole and firmly fastens the bolt.

Trolley frogs should be of 20 degrees, should be placed opposite the track frog, and pulled a little out of line on the straight-of-way, toward the curve. This is necessary on account of the swivel harp construction of mine locomotive trolleys. Track bonding should be under the fish plate, for mine cars frequently leave the track and play havoc with exposed bond wires. For temporary work channel pins and outside wires on one rail are sufficient, but should never be used on main haulage lines.

The usual mine locomotive is equipped with a plug connection from the cable leading down the wood trolley pole to the locomotive circuit. Where side trolley construction is employed the motorman is generally required to change trolley poles every round trip. Placing the socket with a live plug in the dark sometimes causes vigorous action on the part of the station circuit-breaker. A better method is to use two trolley poles, one on each side of the machine, with leads to a double-throw switch.

The trolley pole heads should not be fastened solidly on a wooden trolley pole with a pivoted harp carrying the trolley wheel, for when this pole leaves the wire the swivel head is likely to hook into the overhead wire, and if securely fastened to the pole and the pole is securely fastened to the motor, trouble results. By giving the head a "driving fit" nothing serious can happen, for in case the head hooks onto a wire when the locomotive is in motion it simply slips off with no resulting damage.

It is also desirable for locomotive motors to have split frames, for with this type new pinion or new bearing lining can be put in between shifts, or four hours, while with a solid frame the job takes about three times as long. Furthermore, the brushes should not be dependent upon the tension springs for current supply. Although this construction is obsolete on other classes of machinery, one manufacturer turns out locomotives with this construction, which may cause trouble if the machines have hard duty.

For operation on heavy grades with large loads and light rails or crooked track, tandem locomotives give excellent results. These consist of two-motor machines operating from one four-motor controller. They are slow and cumbersome on short hauls or in switching, but for long, heavy hauls they are much easier on the track than the equivalent machine on four wheels. The cable connecting the two machines should be arranged with plug ends fitting into sockets on the machines and care should be taken that no mechanical strain, due to a pull on the cable, can come on the contacts in normal operation. The maintenance and jumper cable is a difficult matter, especially if the motor operates on crooked track. Hence the desirability of being able to make a quick change of cables.

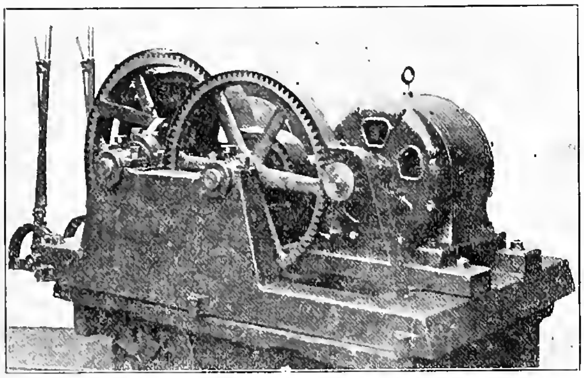
The frictional resistance of mine cars is much greater than might be suspected. Nothing less than 50 pounds per ton should be allowed, a 6½-ton locomotive should handle 69 tons on the level and 39, 26 and 19 tons on a 1, 2 and 3 per cent grade respectively. This would require an input of approximately 67 kw. These figures apply to cars on which divided axles or one loose wheel per axle are used. This construction allows a car to be easily handled on a curve but on reasonably straight track the continual oscillation causes high resistance.

The cost of laying underground track with 25-lb. rails, ties on 18-in. centers, bonds, etc., averages about $3000 per mile. The cost of the overhead in place, 000 grooved trolley wire, is $2400 per mile.

Electric Hoisting.

The substitution of electric for steam and air hoists is attended with great saving. In one instance the equipping of a steam hoist with a 50-h.p., 3-phase induction motor paid at the rate of 150 per cent a year on the investment, while for work at an underground winze or similar locations, the economy may be much more. In such places the average mining man places a small steam hoist and drives by compressed air. It may easily take, under these conditions, 100 i.h.p. at the air compressor to do the work of a 20-h.p. motor. If it is necessary to maintain air pressure outside of drilling hours for hoisting purposes, the efficiency may fall to about one per cent. In applying a motor to a hoist for given duty the minimum efficiency between the motor input and hoisting done may be taken at

46 per cent. This refers to a motor of continuous rating. The size of motor necessary for a steam hoist in operation is best obtained by taking indicator diagrams and expressing the torque in pound-feet. It should be noted that for a given size motor, load and depth of shaft, there is a certain fixed hoisting velocity



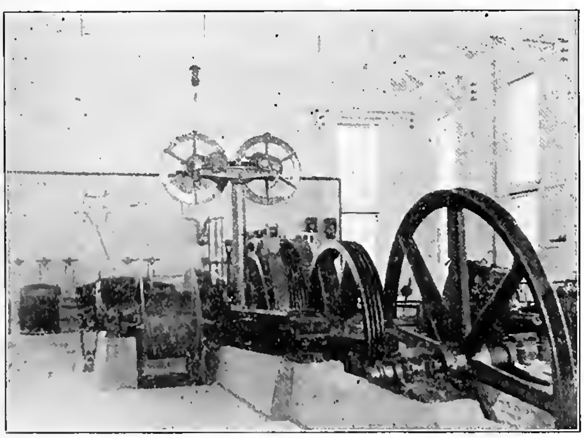
Cripple Creek Type of Electric Hoist.

that will give a minimum hoisting period. A greater velocity loses time in acceleration, and a loss in running time after full speed is reached.

Referring again to the inefficiency of compressed air, I have seen a 350-h.p. air compressor working at top speed to maintain pressure enough on the pipe lines to operate two Cameron pumps, which were subsequently easily driven by one 3-h.p. motor. The efficiency in this case between the steam cylinders of the air compressor and the weight of water lifted was 0.21 per cent. This is an actual case from practice and at a plant that was supposed to be up to date.

Electric Pumping.

The steam pump at its best is an inefficient piece of apparatus. Tests show a compound condensing pump, 20 and 38 x 13 x 36 in., to require about 10 lb.



Balanced Hoist at Union Shaft, Virginia City, Nevada.

of coal per i.h.p., including boiler losses, condensation, etc., while a centrifugal pump, direct connected, has an efficiency of about 61 per cent, or say 5.6 lb. coal per i.h.p. With a plunger pump a better figure than this can be obtained, but the centrifugal is cheaper to install.

The motor for pumping duty should not be wound for over 440 volts. Form wound coils, heavily treated with water-proofing compounds, should be used. The rotor should be of the constant speed type, variation in water flow being taken care of in the centrifugal by throttling the suction, and in the plunger pump by by-passing one or more cylinders.

The pump should be placed as high as possible above the sump to allow ample time for the water to rise in case of accident. With a centrifugal pump no trouble will be experienced with a suction head of 25 ft., barometer averaging 29 in. For heading pumps handling over low lifts a plunger type should be employed, as the pumps must operate without attention and must be self-priming.

Underground Lighting.

Wiring for underground lights should be done very carefully. Ordinary insulation is useless after a few months underground, and reliance has to be placed on porcelain or glass. Weatherproof sockets only should be used and these, preferably, of hard rubber, or composition. Moulded mica disintegrates and porcelain breaks too easily. The number of switches underground should be kept at a minimum and only knife blade types of not less than 50 amp. capacity. Miners always operate switches with a club where possible.

Leads down the shaft should be in iron pipe unless acid water is present. Triple braid, rubber-insulated wires fastened to an iron messenger wire to carry the weight and protected by iron pipe is much more satisfactory than lead-covered cables for this work. A lead-covered cable for vertical work such as in a shaft is a delusion and a snare and is almost sure to give trouble. In one case satisfactory operation was obtained from a lead cable which was installed in the following manner: A 000 stranded, 3-conductor, rubber-insulated and lead-covered cable was fastened to a 5/16-in. galvanized strand wire by tape every 2 ft., and lowered down a 3½-in. pipe, the strand wire taking all the weight. After the full length was in place, about 500 ft., the lower end of the pipe was closed around the cable with cement, the pipe filled with hot sand and the top sealed. The cable was thus supported throughout its length and failure could not take place. The lead covering was practically useless as a protection in this case.

Mill Equipment.

In mill work, when dirty water and a multitude of belts are found, conduit work is the only satisfactory method. Long drops should be avoided, and, as in underground work, the number of switches should be limited. Usually a point can be selected that is central and exposed to a minimum of water and dirt to which all lighting circuits should be run.

Incandescent lamps should be low priced, the efficiency being sacrificed for this point. Where power is generated by the owner at low cost there is no economy in buying high efficiency lamps that soon become covered with a more or less opaque coating of mud and dirt, or else broken. In such cases, where the cost of the power required to operate a lamp is a fraction of its initial cost, it is advisable to keep the

initial cost low, at the expense, perhaps, of a slight increase in the operating power cost.

The use of electric motors in driving concentrating mill machinery is quite common. The delays in a mill driven by a line shaft running the full length of the mill and driven by a steam engine at one end are many times the delays in a properly subdivided and electrically driven concentrator. For example, in the same field a mill of the first class is operating with delays averaging 9.6 seconds per ton milled per day, while nearby another of the second class has delays of 27 seconds per ton milled per day.

The induction motor is the only one that should be considered for this class of work, and for this duty high-efficiency, high-power factor machines should be overlooked for motors with a rather large air gap, form wound coils and a generous rating. The use of partially closed slots with coils formed in place is sure to bring trouble in work of this character where dirt, water, and usually more or less indifferent attention and care are given the machines.

After a motor of the partially closed slot type has had good steady use and it becomes necessary to replace a few coils it is usually found that the insulation on the other coils is so brittle that they cannot be taken out of the slots without damaging the insulation beyond repair. It then becomes necessary to rewind the entire machine, when with wide-open slots a few new coils would have been sufficient.

The rotor for mill work can generally be of the squirrel-cage type, but should have a rather high resistance so a good torque can be had on starting. The connections between the rotor bars and end rings should have ample area and depend for mechanical strength on rivets or screws.

For operating the crushers, a motor with slip rings and external resistances of suitable capacity for continuous operation should be used, as crushing machinery is liable to have large inertia. In one case a section comprising a 24 x 42-in. Blake type crusher and three 24 x 48-in. rolls required full load torque from a 250-h.p. motor for 7 to 15 minutes to get up to speed. After reaching speed the power required was 114 h.p., unloaded. On crushers and rolls the motors should be protected by circuit-breakers with an inverse time limit attachment, so that momentary peaks do not throw the load off and leave the crusher choked. For other classes of work the plain fuse is all that is required.

On large centrifugal pumps for mill work there is an excellent opportunity to use synchronous motors and furnish some of the magnetizing current required by the induction motors. No trouble will be experienced with the synchronous motor starting as an induction motor on reduced voltage, when directly connected to a pump, if a short-circuited winding is applied to the field poles.

The motor circuits should be in conduit, differing from the lighting circuits in that there should be plenty of switches to subdivide for the purpose of repairing or attaching new branches. Milling is a continual change and usually the plant is no sooner running than there will be changes or additions to be made. At each motor there should always be placed a switch disconnecting everything from the line, so fuse blocks, circuit-breakers or compensators may be repaired without danger. It should be remembered in this connection that in milling work 24 hours a day and six days per week is the minimum working time allowed and often the plant will run continuously, hence suitable provision must be made for repair work.

Motors should never be on the same floor with jigs or tables, but should be placed on piers at least 40 in. high or in the roof trusses, the latter being better. The writer has noticed careless jig men play a hose directly in a motor, not so placed, for several seconds at a time, which is hardly beneficial.

Telephones.

The telephone system for any but a small proposition should be the manual in preference to the automatic, as the telephone operator is a handy person to do small chores, which in the automatic the calling party would have to do himself or leave to his assistant at a greater expense in salary perhaps than an operator would cost. A generous use of telephones always pays. They should be underground at the principal points as well as on the surface. The lines in the shaft should be of No. 14 double-braided, rubber-covered wire fastened to a galvanized iron wire as a messenger and lowered in ¾-in. pipe with the ends sealed with compound. Any other type of construction will give trouble. In the workings the wire should be carried clear of everything on large insulators or else in pipe and the point of changing from conduit to open work should be in a dry place. The telephone instrument itself, for underground work should be mounted in an iron box with a tight-fitting door. By mounting a 16-c.p. lamp inside the box to keep it warm as satisfactory service can be had underground as on top. If the warming lamp is left out moisture will make short contacts in a few weeks, so that on a common battery system, which is preferable to a magneto, the line will show busy.

Usually when a telephone is mounted in a mill the vibration makes conversation almost impossible. Sound-proof booths, so called, are of no avail, but if the transmitter is suspended from a coil spring about 4 in. long the vibration disturbances will be eliminated. The same construction can be supplied to advantage in the engine rooms or any place subject to powerful vibrations.

If power circuits are adjacent to telephone lines, plenty of protection in the way of fuses should be provided. Where the wires enter the cable, fuses and arrester equipment should be used and again at a distributing rack before entering the switchboard. Each instrument should be protected by arrester and fuse. By using ½ amp. fuses at instruments and cable box, and ¼ amp. in the distributing rack, and also by having two spark gaps in series to ground at the cable box, light disturbances will blow out only the ¼ amp. fuses; these are accessible and easily replaced. A heavy discharge or cross with a power line will open all fuses. On a telephone system constructed as above an accidental cross with a 10,000-volt power circuit did not reach the switchboard or instruments, the fuses and lighting arresters completely protecting the equipment.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER V.

THE MERCURY FLOTATION WATTHOUR METER.

(Continued.)

The Mercury Flotation Watthour Meter.

The Sangamo Electric Company of Springfield, Ill., manufactures a type of watthour meter which is radically different in operation from the induction and commutating types of meters previously explained. The Sangamo meter is of the mercury flotation type and its principle of operation is based on an old discovery made by the scientist, Faraday, when he found that a pivoted metallic disc carrying electric current would tend to rotate when under the influence of a magnetic field.

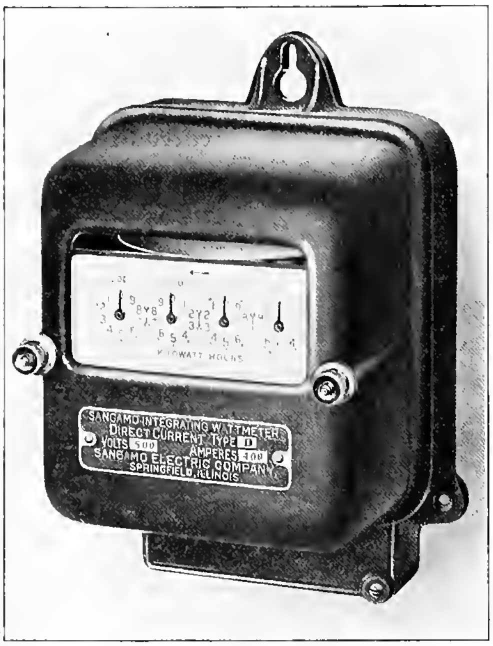


Fig. 61a. Sangamo Meter.

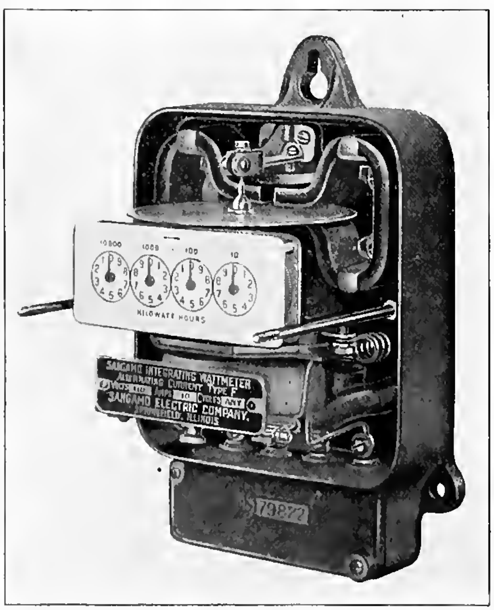


Fig. 61b. Sangamo Meter, Cover Removed.

The fundamental discovery of Faraday is very ingeniously utilized in the Sangamo meter. A copper disc is enclosed in a suitable chamber made of moulded insulating material which is divided horizontally into two sections, the chamber being partially filled with mercury. In the lower part of the mercury chamber there are imbedded two copper terminals which serve to conduct the current to the copper disc through the intervening mercury. The mercury serves the double purpose of conducting the current to the disc and of buoying up the disc so as to make the weight on the lower bearing very slight. The copper terminals are arranged diametrically opposite as will be seen from Fig. 62. The exciting magnet which produces the flux which acts upon the disc is imbedded in one section of the moulded "mercury chamber."

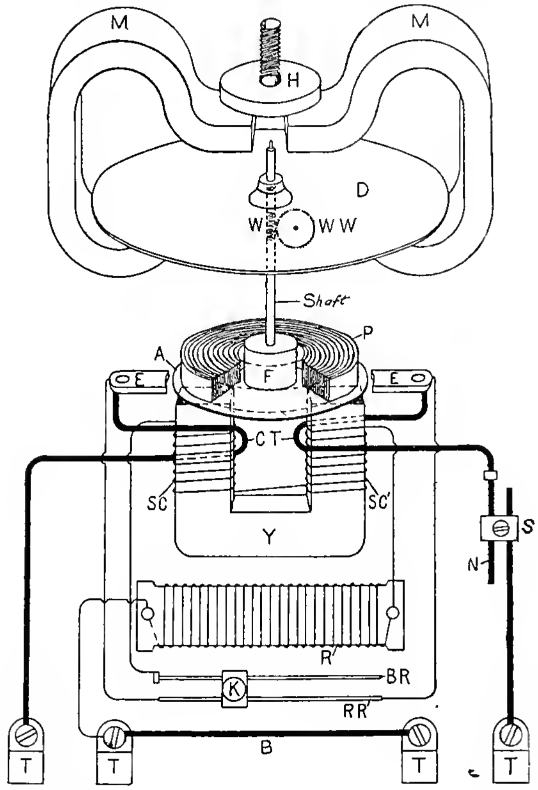


Fig. 62.

In the case of the direct current Sangamo meter the main line current, or a proportional part thereof, passes through the copper disc, the magnet being excited from the potential of the circuit upon which the meter is being used. In the case of the alternating current meter, the method of excitation is opposite from the direct current meter, that is, the magnet is excited by the line current, and the disc carries a current which is proportional to the potential of the circuit.

The reaction of the current in the disc with the magnetic lines of force from the magnet will cause the disc to rotate at a speed which will be proportional to the product of the current and the impressed e.m.f., in other words, it will rotate at a speed which will be proportional to the power being expended in the circuit

to which it is connected. In alternating current meters operating on a circuit whose power factor is other than unity, the speed of rotation will then be proportional to the current, the e.m.f., and the power factor.

Under ordinary conditions a variation in temperature between 10° F., below zero, and 110° F., will not materially affect the operation of the mercury meter, but temperatures above or below these maximum and minimum values are liable to affect the accuracy. There is sufficient space in the mercury chamber and such a (comparatively) small percentage variation in the volume of the mercury with changes in temperature that the expansion of the mercury will not cause it to leak out, as is sometimes supposed.

The direct current Sangamo meter cannot be used on alternating current circuits because of the high self-inductance of the potential winding. Therefore, if alternating current be applied to a direct current meter very little current would pass through the potential coil, and even that would lag by so many degrees that it would produce a very small torque.

Fig. 62 shows diagramatically the Sangamo direct current meter. The damping system in this type of meter is essentially the same as previously explained in connection with induction and commutating types of meters. In the above figure the damping magnets are shown at M, and the damping disc at D. The copper terminals which lead the current into the mercury and thence to the disc, A, are shown at EE. The external resistance, R, is in series with the potential winding, SC. The light load adjustment is made by moving the slider, K, to the right or left, thereby causing part of the shunt current passing through the potential winding to flow through the armature. This current reacting with the magnetic field from the potential winding produces a no-load torque which is sufficient to compensate for friction.

The torque of the Sangamo meter is very low, the torque of a 5 ampere direct current meter being only about 20 gram-millimeters. It may be said, however, that in the case of the mercury flotation meter the pressure on the jewel bearing is relatively small, and it is therefore not necessary to have as high a torque as in other types. The reason for this low torque in the Sangamo meter is due to the fact that the armature is equivalent to only one turn, and as it is not practicable to carry more than 8 or 10 amperes through the armature, the effective armature turns will necessarily be low. Current shunts are used in all direct current Sangamo meters having a capacity of more than 10 amperes, the shunt being external in large capacity meters and internal in the smaller sizes. The sliding connector, S, shown in Fig. 62 is used for adjusting the armature current with respect to the shunts.

It is not feasible to build the mercury meter for three-wire direct current service, since it would necessitate the construction of two separately insulated mercury chambers and armatures, which would of course be too bulky, complicated and expensive to be warrantable. Two mercury meters have to be used where it is desired to measure the power in a three-wire direct current circuit, with this type of instrument.

The alternating current meter of this type is shown diagramatically in Fig. 63. As will be noted, the armature circuit is in shunt with the source of supply in this case, as was above mentioned, rather than in series as is the case with the direct current type. The small potential transformer, N, has its primary, PT, connected across the line and induces through its secondary, MS, a current of high amperage and very low e.m.f. This current flows directly through the armature as is shown. The actual value of this secondary current is between 12 and 20 amperes at an e.m.f. of approximately 0.05 volt. The transformer also has an auxiliary secondary winding, AS, the terminals of which are connected through the variable resistance, RR, to the light load adjusting coil, J, which is wound on the same core with the series field coils, FC. By moving the slider, K, along the resistance the compensating effect of the light load

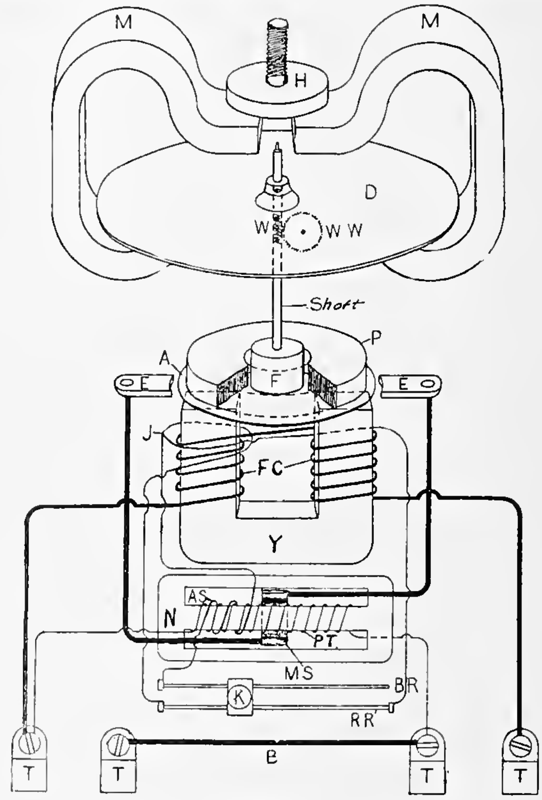


Fig. 63.

The full load adjustment in the Sangamo meter is quite different from the usual practice, in that the damping effect of the retarding magnets is varied by "shunting" more or less of the magnetic lines through a soft iron disc, H (Figs. 62 and 63), which is placed directly above the magnet system, rather than by moving the magnets themselves. This soft iron disc is movable in a vertical direction as shown; by bringing it in close proximity of the magnets, it weakens their effect, thereby causing the meter to run faster.

The Ampere-Hour Meter.

The Sangamo ampere-hour meter, is now being used quite frequently in connection with the charging and discharging of storage batteries. Storage batteries are rated on their ampere-hour capacity, and it will therefore be seen that an instrument which will indicate the amount of current that has been stored in, or the amount of current remaining in a battery is a

valuable accessory to the electric automobile garage, or in fact to any one having the care of a storage battery.

The construction of the Sangamo ampere-hour meter is essentially the same as that of the watthour meter, except that the exciting electro-magnet is replaced with a powerful permanent magnet. The turning effort of the armature will therefore be independent of the potential of the circuit on which the meter is used, being directly proportional to the current passing through it. This type of meter is usually furnished with a single pointer, which will show at a glance the condition of the battery with respect to the charge or discharge. The dial may be furnished with a movable contact, which by means of a relay can be made to open the main circuit through a "shunt-trip" type of circuit-breaker; this movable contact can be set so as to open the circuit at any predetermined value.

Connections.

A few representative connections of the Sangamo meter are shown in the following figures:

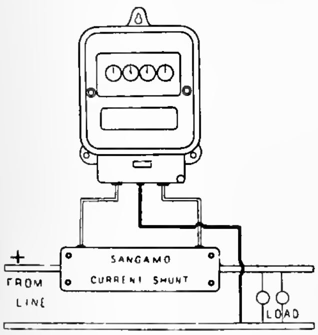


Fig. 64.

Two-Wire D. C. Meters—110 to 250 volts; 100 to 400 amperes, inclusive, box type "Current Shunt." New "Pocket Type" Shunt used in capacities 100 to 200 amperes, inclusive, except for street railway service.

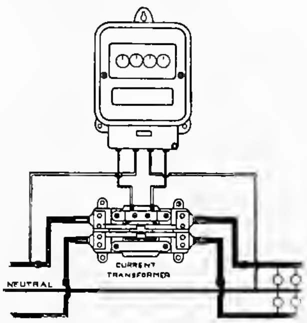


Fig. 67.

Three-Wire Alternating Meters—110-220 volts single-phase; capacities 200 amperes per side and over. With Current Transformer having two primary windings.

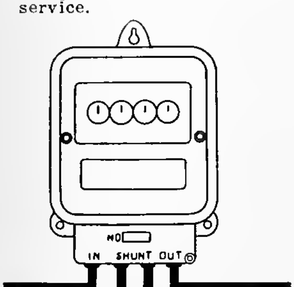


Fig. 65.

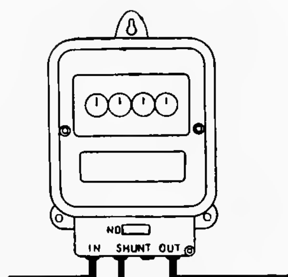


Fig. 66.

Two-Wire Meters—110 and 220 volts, for A. C. Meters 5 to 100 amperes; D. C. meters 5 to 80 amperes, inclusive. Meters may be connected according to Fig. 65 or Fig. 66, but the former is preferable, as this method prevents tampering with the meter connections.

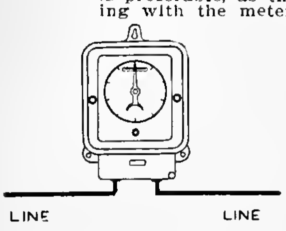


Fig. 68.

Service type, ampere-hour meter, 10 to 100 amperes internally shunted.

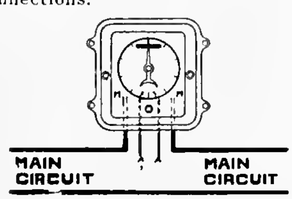


Fig. 69.

"Auto" type, ampere-hour meter, with contact device and auxiliary circuit for tripping a circuit-breaker. Capacity 10 to 100 amperes,

(To be continued.)

ELECTRIC MINE HOISTS.

The March meeting of the American Institute of Electrical Engineers in New York City was devoted to a discussion of electric hoisting in mines. Two papers were presented, one by D. B. Rushmore and K. A. Pauly was mainly devoted to a comparison of different systems, and the other by Wilfred Sykes detailed the mathematical calculation of load diagrams and a descriptive account of the various balancing systems. Following is an abstract of the descriptive and comparative portions developed in the first paper.

Mine hoists are usually driven by either shunt-wound direct current motors or by polyphase alternating current induction motors. Speed variation with the shunt motor is best obtained by changing the supply voltage. Speed control of an induction motor is obtained by changing the amount of resistance connected in its armature circuit. In lowering unbalanced loads the shunt motor may be driven as a generator, acting as a brake at all speeds and returning power to the system. The induction motor also generates but only when driven above synchronous speed.

For a given torque the input to the shunt motor is approximately proportional to the speed, while that of the induction motor is constant and independent of the speed. At low speeds the shunt motor is consequently the more efficient. The free-running speed of each motor is limited and change in load has little effect upon speed variation.

As pointed out, the efficient speed control of the shunt motor is only obtained by varying the voltage of the supply system, the usual method being to provide a generator for each motor and varying the generated potential. As mine shafts are usually scattered over a considerable area, and the conditions in close proximity to the shafts are not such as to permit of the economical generation of electric power, the central electric station is usually placed at a considerable distance from the hoists, the power is generated and transmitted to the mines as alternating current and is then transformed at each shaft into direct current by motor-generator sets. The losses caused therein must be charged against the shunt motor when comparing its efficiency with that of the induction motor, which may be connected either directly or through highly efficient static transformers with the alternating current distributing system. The torque and current for the two types of motor are approximately proportional within their operating limits.

Mine hoists may be divided into six types, depending upon whether the rope is wound on a reel, a cylindrical drum, conical drum, cylindro-conical drum, Whiting drums, or carried over a Koepe disk, the choice of any particular type depending largely upon the depth of shaft, the maximum permissible hoisting speed, the location of the hoist with respect to the shaft, the number of levels which are being worked simultaneously, and whether or not the shaft conditions permit the use of a tail rope.

The hoists are generally operated in balance, that is, the weight of the skip (or cage and car as the case may be) carrying the ore, is balanced by a similar empty skip which is lowered in a second compartment simultaneously with the hoisting of the loaded skip in the first, the loaded skip being dumped at the top and

the empty one loaded at the bottom, and the cycle then repeated. To permit of adjustment of the length of the ropes for hoisting from different levels, it is customary to use two reels or drums mounted on the same shaft, one being keyed to the shaft and the other being driven by it through some form of clutch. The length of rope on the Koepe disk hoist or the Whiting hoist cannot conveniently be adjusted for different levels except within very small limits.

Many systems of electric hoisting have been proposed, each with the view of meeting some peculiar condition, or eliminating some real or apparent objection in the others, but virtually all the installations are confined to four systems shown in Figs. 1, 2, 3 and 4.

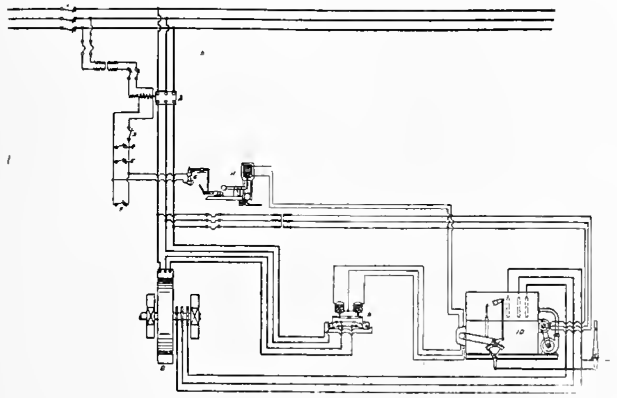


Fig. 1

The first and simplest system is shown in Fig. 1, and consists of a polyphase induction motor, direct connected or geared to the hoist drum. The speed of the motor is controlled by a variable resistance in its rotor circuit, which, because of the magnitude of the currents involved, is usually some form of water rheostat. A common type of water rheostat consists of a tank, usually of boiler plate riveted together, and divided into two compartments; one the rheostat proper, and the other a cooling tank. The electrolyte is pumped from the cooling tank into the rheostat proper, entering at the bottom of the rheostat and flowing out over the top of an adjustable weir, back into the cooling tank. The resistance in the rotor circuit is varied by changing the height of the electrolyte in the rheostat proper by means of the adjustable weir. The electrodes are usually thin iron plates hung on insulators, all phases being in the same compartment. At least one electrode per phase is of extra length, extending below the lowest level of the liquid, in order to prevent the rotor circuit from being opened. The most common form of electrolyte is a simple salt solution. The control of the rheostat is by means of a lever located on the operating stand.

The horsepower and current taken by the motor are constant during the period of acceleration; the efficiency for this period is very low, approximately 45 per cent. No power is returned to the supply system during the period of retardation, and the power consumption for small movements of the cage or skip is very large. On the other hand, the efficiency when the hoist is running at full speed is high, approximately 90 per cent, and no power is consumed while the hoist is at rest. About 20 per cent of the power taken for hoisting is returned in lowering.

The second system is that shown in Fig. 2. In this system the hoist is driven by a direct-current shunt-wound motor receiving power from the alternating-current supply system through a synchronous or induction-motor-generator set. The hoist motor is controlled by varying the voltage of the generator, which is separately excited, one generator being used for each motor.

The power consumed during acceleration is much smaller than for the induction hoist motor, the efficiency then being approximately 80 per cent, and a considerable part of the energy stored in the revolving parts of the hoist is returned to the supply system as the hoist is brought to rest. On the other hand, the

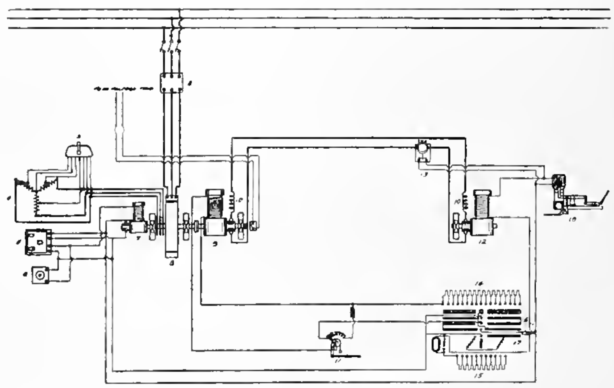


Fig. 2

efficiency when the hoist motor is running at full speed, is lower than that for the induction hoist motor, being approximately 82 per cent, and the losses of the motor-generator set when running light, must be supplied during the time when the hoist is at rest. In view of the fact that a mine hoist is idle 50 per cent or more of the time under ordinary conditions, this is an item in the total power consumption which cannot be neglected. It follows from what has been stated, that the advantage of the direct-current hoist motor over the induction hoist motor in the efficiency through the complete cycle is greatest for short lifts, in which case the period of acceleration is a large percentage of the total cycle and the time during which the hoist is idle is a minimum. Approximately 30 per cent of the power consumed in hoisting the ore unbalanced is returned to the system when the skip is lowered.

No definite rule can be laid down by which a choice can be made between the two systems, each having advantages and disadvantages peculiar to itself which have a more or less important bearing on the choice, depending upon the special conditions of the individual problem. The first system has the advantages of low first cost and simplicity, but is often at a disadvantage in respect to efficiency. On the other hand, the higher efficiency of the second is frequently more than offset by its increased first cost and its greater cost of maintenance.

Both systems are open to objection that the power drawn from the supply system fluctuates between very wide limits during each cycle, generally reaching a maximum during acceleration, becoming negative during retardation for the second system, zero, or practically so, at the end of the cycle, and negative when lowering unbalanced for both systems. The effect of

this wide fluctuation in the load during each cycle, is to seriously impair the voltage regulation of the supply system unless its capacity is large as compared with the fluctuations, or unless the number of hoists driven from the same system is sufficient to produce a fairly uniform load, which is seldom the case for a mine power system. Also, if power is purchased, the price is usually made up of two components; one based on the total kilowatt hours consumed, and the other on the maximum demand.

It therefore becomes necessary in most cases to provide some means whereby power may be taken from the supply system and stored during the portion of the cycle when the demand for power is less than the average, and returned when the demand exceeds the average.

Fig. 3 shows such a system, the third, in which advantage is taken of the low first cost and efficiency of the fly-wheel as a means for storing and returning large quantities of power for short intervals. This system is similar to the second, except for the addition of a fly-wheel to the induction motor-generator set, and an automatic regulator for varying its speed. In its most common form, this regulator consists of a water rheostat connected in series with the induction

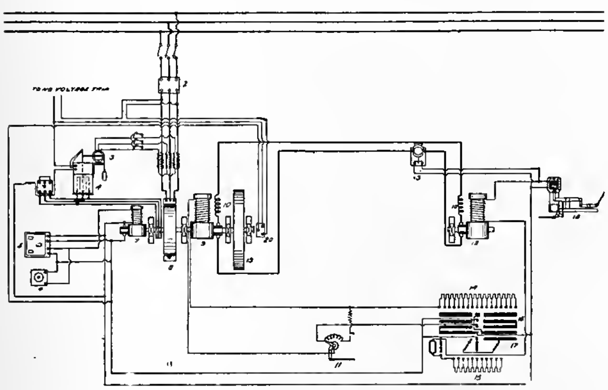


Fig. 3

motor armature. The resistance is varied by means of movable electrodes suspended from an arm mounted on the shaft of an induction motor, which is connected in series, either directly or through series transformers, with the induction motor of the fly-wheel set. The regulator motor is so connected that its torque opposes the weight of the electrodes, which are partially counterbalanced to reduce the size of the regulator motor to a minimum, and permit of an adjustment of the regulator for different values of line current. When the line current exceeds the value for which the regulator is adjusted, the torque of the motor overbalances the weight of the electrodes, lifting them and inserting resistance in the armature circuit of the induction motor. This causes it to slow down, and allows the fly-wheel to assist in driving the generator during the peak loads.

The fourth system is used when, for the purpose of meeting some peculiar condition, it is advisable to drive the hoist by an induction motor and at the same time eliminate the peaks from the station load. The adoption of this system is warranted when the hoist is located underground at such a distance from the surface that it becomes necessary to transmit power to it by alternating current, and when the shaft is not large enough to allow the fly-wheel of the motor-generator set to be taken underground.

Fig. 4 shows this system, which it will be noted is the first system, to which has been added a converter equalizer, consisting of a rotary converter

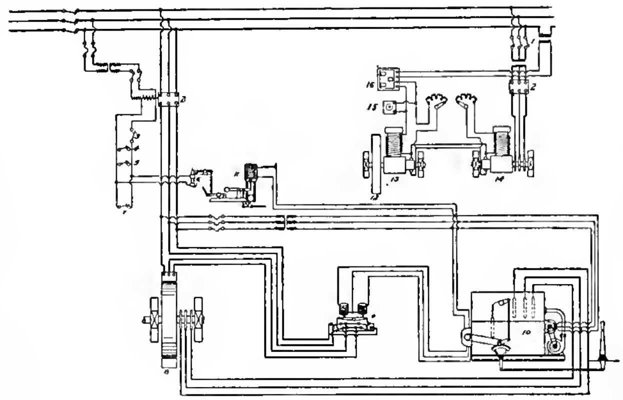


Fig. 4

connected on the alternating-current side to the supply system, and on the direct-current side to a motor driving a large fly-wheel. The field of the direct-current motor is controlled by a regulator actuated by the line current. When the power taken by the hoist

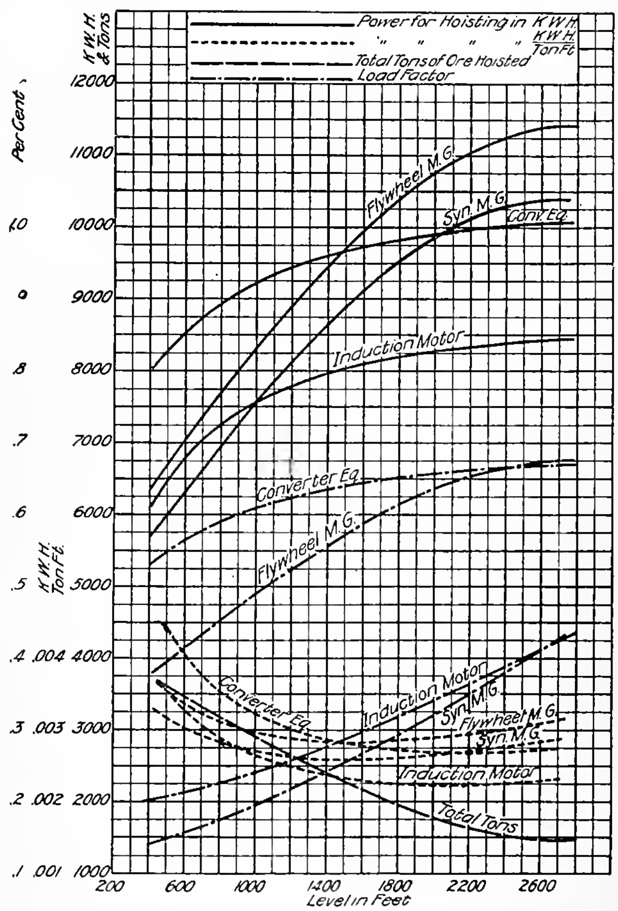


Fig. 5.

motor drops below the average, the field of the motor is automatically reduced, and the fly-wheel is speeded up, the power being taken from the supply system.

When the hoist-motor load exceeds the average, the operation is reversed, the fly-wheel slowing down and returning power to the system.

The efficiency of this system is generally slightly lower, and the weight of the fly-wheel is slightly greater than for the direct-current motor and the fly-wheel motor-generator set. It has the advantage, however, over the third system, in that the operation of the hoist motor is not dependent on the operation of a converter equalizer. Consequently, in the event of the failure of the latter, hoisting may be continued, providing, of course, that the capacity of the power system is sufficient to take the load, which would be the case if the equalizer were used simply to reduce the power bill.

Either the third or the fourth system may be used where the supply system is direct current, by substituting a direct-current motor for the induction motor of the fly-wheel motor-generator set in the third system, and omitting the synchronous converter of the fly-wheel converter system in the fourth.

The curves in Fig. 5 give the total tons hoisted, and the total kilowatt-hours consumed (per day of 24 hours), the kilowatt-hours consumed per ton (2000 lb.) foot, and the load factor for each of the four systems when hoisting 10,000 lb. per trip in balance from vertical depths varying from 400 ft. to 2600 ft. by a reel hoist.

PRACTICAL MECHANICS.

Paper 12.

TOOTHED GEARING.

In the present paper we shall take up the case of transmission of pure rotation by means of toothed gearing.

Toothed gearing is a special form of friction gearing and is included in the second of the five divisions of mechanical transmission which were outlined in the first of this series of papers. (See Journal of Electricity for Jan. 1st, 1910.)

Toothed gearing possesses certain advantages over friction gearing, which advantages are the entire elimination of pressure normal to the disc surfaces and the consequent absence of bearing adjustments necessary to maintain this pressure. As a result of this, toothed gearing has come into general use except in cases where it is sometimes necessary that slipping be permitted. Further, it is possible to transmit enormously greater amounts of power than could be done through friction gearing.

As in the previous cases, we shall investigate our subject under the three conditions:

First. Axes of rotation parallel; spur gears.

Second. Axes of rotation intersecting; bevel wheels.

Third. Axes of rotation crossing; skew wheels.

We shall consider at some length the design of spur gear teeth and touch, more briefly the other two forms, since the same principles of design are involved in all three cases.

Toothed gearing is a special form of friction gearing in which certain projections upon and depressions within the rotating bodies are made to mesh, so that they are driven by direct contact.

In the case of friction gearing the velocity ratio was found to be constant for circular bodies, and inversely equal to the ratio of their respective radii. In the case of toothed gearing the same relations exist. If we were to consider two circular discs, one driving the other through frictional contact, the circumferences of these discs would be known as the pitch circles. In friction gearing these pitch circles are imaginary, but serve to determine the velocity ratio and distance between axes just as the actual discs do.

Any sort of projections and depressions would serve to effect transmission of motion from the one body to the other, but to insure a constant velocity ratio it is necessary that the imaginary pitch circles be considered.

In all cases, then, of toothed gearing the teeth are considered as fixed upon these imaginary pitch surfaces. The diameter of the surface is known as the pitch diameter, and the distance from the face of one tooth to the corresponding face of the next tooth on the same wheel measured on an arc of the pitch circle is called the pitch of the tooth, or the circular pitch.

The design of the tooth surfaces so that the angular velocity ratio may be constant, the driving positive, and the velocity of sliding as small as possible, is the chief problem.

There are three forms of teeth which have been found to accomplish the above requirements with the best results. These are known as the epicycloidal, the involute and the conjugate teeth.

We shall study the epicycloidal tooth first. A cycloid is the curved path traced out by a point on the circumference of a circle when this circle is rolled

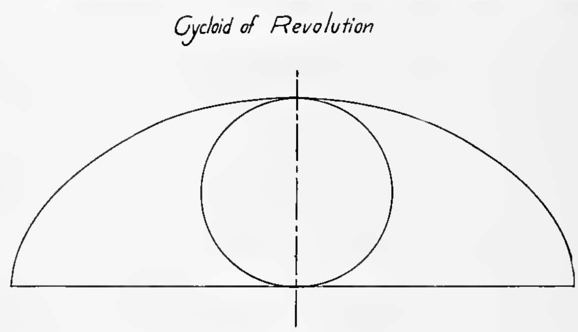


Fig. 24.

along a plane surface. Figure 10 shows such a cycloid of revolution. If the same circle were rolled around the circumference of another circle, the point of the first circle would describe an epicycloid, and if it were rolled on the inner circumference the path generated would be termed a hypocycloid. Figure 11 shows an epicycloid and a hypocycloid generated by such a circle rolling on the exterior and the interior of an arc of a larger circle.

Figure 12 shows the application of this cycloidal curve to gear teeth. The two circles with centers at A and B are pitch circles in rolling contact at I. The generating circle with center at S is in contact with both circle A and circle B at I. A point on circle S therefore generates an epicycloidal curve e_oe with reference to circle B and a hypocycloidal curve h_oh with reference to circle A. The point P is, at the instant, under consideration, generating these two cycloids, and is therefore their point of contact.

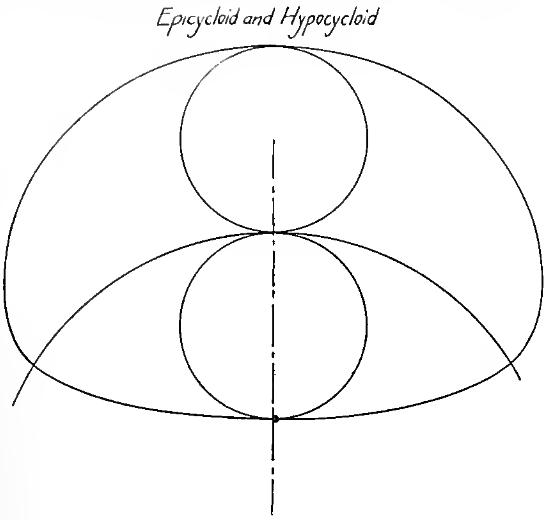


Fig. 11.

In the completed gear this point of contact P is the point where the actual driving is done. It will be remembered that the first requirement for successful gearing is a constant angular velocity. Since the

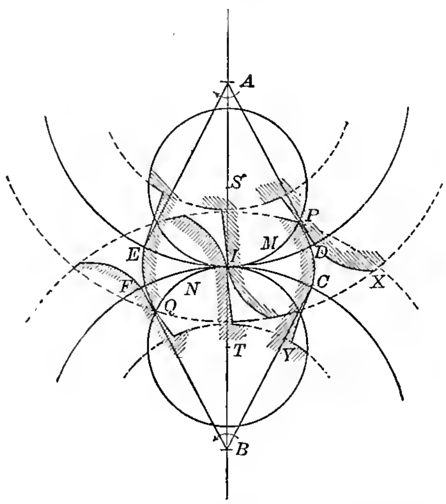


Fig. 12.

velocity ratio is inversely proportional to the respective radii of the circles A and B, their point of contact I must be fixed in position—i. e., must remain in such a position that the ratio $\frac{AI}{BI}$ is constant.

Now, I is the center of relative motion between A and B. It will be remembered from an earlier paper that the three centrodes of motion must lie on the same straight line.

It may seem, at first thought, that the cycloidal development of Figure 12 does not fulfill the above necessary condition for constant velocity ratio, but a little further study will show that it does so.

The only possible motion of the two cycloids e_oe and h_oh is a sliding motion at the point of contact P. This sliding must be in the direction of the common tangent to the surfaces or perpendicular to the common normal PI. (It can be shown that this common normal will always pass through the imaginary point of contact I.) Hence the relative motion due to the sliding at P is the same as though the pitch circles were actually in rolling contact at I.

Therefore it may be said that for a constant angular velocity ratio the tooth outlines must be such that their normal at the point of contact shall always pass through the centrode corresponding to the required velocity ratio.

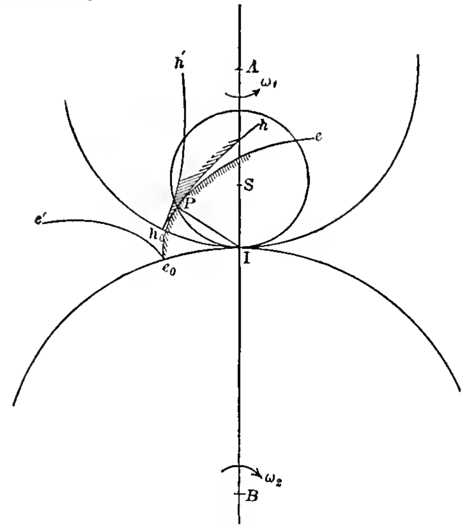


Fig. 13.

In the figure (13) driving will take place on the left side of the line of centers AIB, and the curve (h_oh) will push the curve (e_oe) along, A being the driving and B the driven circle. As P approaches I, however, h_o approaches e_o until they eventually coincide at I. Beyond I to the right the curves e_oe and h_oh are no longer in contact, but another pair of cycloids, e_oe^1 and h_oh^1 are traced out. Obviously now the driving could not be from A to B since the tendency would be for h_oh^1 to separate from e_oe^1 instead of to drive it forward by pushing as on the left side of the line of centers.

This may be overcome by using a describing circle similar to circle S within each of the pitch circles.

Figure 13 shows the complete tooth development in this manner. In addition to describing circle S there will be noted describing circle T. The action of these two circles in describing the teeth tips and flanks is as follows: Point P of describing circle S traces the face PC of the tooth of B, and the flank PD of the tooth of A; while the point Q of the circle T traces the face QE=face DX of the tooth of A, and the flank QF=flank CY of the tooth of B.

We see that in this case the locus of contact of two teeth will be PMINQ, and hence the driving is continuous from the first instant of contact to the point of separation on the opposite side.

Any two gears having the same pitch of teeth will mesh together and work correctly, provided that the same describing circle has been used in laying out the tooth surfaces. The reader who desires to fix the principles of cycloidal teeth development well in mind should lay out the tooth surfaces on paper, drawing in the various curves for himself.

In laying out the teeth of a complete gear it would be necessary to carefully develop the surface of one tooth and from this surface make a template. By

swinging this template along the pitch circle the successive tooth surfaces may be quickly and accurately drawn in, the circulan pitch having been previously determined and indicated on the pitch circle.

The determination of the circular pitch is made with consideration of the size of the gear and the amount of power to be transmitted.

If the speed of the driving shaft, say, is known, and the amount of power to be transmitted then the torque, or turning effort at the pitch circumference of the gear may be calculated. Thus, if F = the force to be transmitted at the pitch circumference of radius r, N = the number of revolutions; then the work $W = 2 \pi r F N$ from which

$$F = \frac{W}{2 \pi r N}.$$ Or since horsepower = work per unit time this may read $$F = \frac{HP.\ 33{,}000.}{2 \pi r N.}$$

When this maximum force is known the teeth may be given proper proportions. The dimensions upon which the tooth depends for strength are the thickness, the length (width of gear face) and the depth of space between teeth. As soon as the pitch is known these values become fixed. As a result of practice the length and depth of teeth for good working proportions, may be assured, while the thickness is at once fixed by the circular pitch.

Before porceeding to the actual design of a definite gearing where the proportions of the teeth will be completely worked out, we shall take up the consideration of the involute system of tooth outline. It will then be possible to carry both applications through at once and to make some interesting comparisons.

HEAT VALUE OF FUEL OIL.

R. F. CHEVALIER.

The commercial value of fuel depend upon:

1. Its available heat units.
2. The cost of mining and transportation to the market.
3. The cost of handling, and if machinery is used, the maintenance cost of same to stoke the fuel.
4. The cost of furnace up-keep.

The advantage of oil over coal as a fuel for the Pacific Coast has been discussed so often, both in first cost of the fuel and cheapness of handling, that it is not necessary to go into these oft-repeated details As there has always been a question as to how many barrels of oil are equivalent to a ton of coal, it is not amiss to reproduce the following article on the "Relative Values of Oil and Coal Fuel," published by the writer in the Journal of Electricity, Power and Gas, May 9, 1908:

The relative commercial value existing between coal and oil as fuel, irrespective of the cost of handling, is shown by the following data. This data is taken from tests made on the same type of boilers (Parker water-tube). The test on the boiler using coal was conducted by Prof. H. W. Spangler, at the Philadelphia Rapid Transit Company, Philadelphia. The test on the boiler using oil as fuel was made by the writer at Tubbs Cordage Company, San Francisco.

The data respecting the oil fuel were taken from one of a series of tests, and show the maximum efficiency obtained with the boiler under commercial operating conditions and a variable load.

As the rating of the boiler using coal is 700 (boiler) h.p., and that of the one using oil only 200 (boiler) h.p., naturally the highest efficiency would be obtained with the former; thus coal is favored. The coal-burning boiler was equipped with a mechanical stoker; and it is interesting to note the relative amount of steam used to operate the stoker, and that used by the burner to atomize the oil.

It is also interesting to note the comparison of the composition of the gases of combustion and the per cent of excess air above the amount theoretically required for perfect combustion by the different fuels. The per cent of builder's rating developed was practically the same, and the steam was superheated in both instances.

The coal used was fine anthracite. The oil was California crude oil as sold by the Standard Oil Company for fuel purposes, and from which the lighter hydro-carbons had been distilled. The heat value and other data pertaining to the fuel, as well as a comparison of the results and efficiencies obtained with the same, are shown in the following tabulation:

Fuel.	Coal.	Oil.
Gravity of oil, Baume		16.2°
Per cent of moisture in fuel	3.9	1.5
Per cent of ash	17.87	
Calorific value, by Parr Calorimeter, per pound of dry fuel, B. T. U	11,811.	18,099.
Boiler Horsepower.		
Horsepower developed, A. S. M. E. rating	832.3	241.
Builder's rated horsepower	700.	200.
Per cent of builder's rating developed	118.9	120.
Economic Results.		
Water apparently evaporated under actual conditions per pound of fuel	7.118	13.12
Equivalent evaporation, F. & A., 212° F. per pound of fuel	9.0767	15.11
Same per pound of dry fuel	9.4451	15.34
Same per pound of combustible	11.83	15.34
Efficiency.		
Efficiency of boiler	82.76	81.8
Per cent of steam generated used by stoker	5.8	
By burner		3.58
Analysis of Dry Gases by Volume.		
Carbon dioxide	7.82	14.6
Oxygen	7.50	1.2
Carbon monoxide	.13	.00
Nitrogen	84.55	84.2
Per cent of excess air above amount theoretically required	50.	5.6

Assuming the cost of coal to be $4.00 per long ton, and the cost of oil to be $1.00 per barrel, the following comparisons can be deducted:

From the results as above tabulated we have an evaporation of 122.4 pounds of water per gallon of oil, cost of this gallon being $0.024. An equivalent evaporation required 12.96 pounds of coal at a cost of $0.023. This places the fuel value of oil at $0.023 per gallon, or $0.96 per barrel of 42 gallons.

Making further deductions from the above figures, we find that a barrel of oil is evaporating 5140 pounds of water; 544 pounds of the above coal were required to do the same work. Therefore, a long ton of such coal would be equivalent to 4.12 barrels of oil.

From various other data, the writer has found that the relative values of the two fuels bear approximately the same ratio.

PHYSICAL PROPERTIES OF FUEL OILS

KIND	Gravity at 60° F.		Flash Point	Water Contained. Per Cent.		British Thermal Units Oil Corrected for Moisture.	
	Specific	Beaume	Deg. F.	By Gasoline	By Distillation	Per Pound	Per Barrel
Bakersfield crude	.9689	14.5	Over 200	4.5	9.6	17858	6054397
Bakersfield crude	.9687	14.56	Over 200	2.0	4.5	17849	6051864
Treated oil	.9642	15.2	290	...	0.2	19040	6126000
Mixture of Coalinga and Bakersfield crude	.9635	15.31	228	...	0.3	18725	6314075
Treated oil	.963	15.37	258	...	0.3	18699	6301731
Treated oil	.9623	15.49	275	...	0.1	18782	6325777
Treated oil	.9594	16.2	...	...	1.5	18100	6077980
————	.951	17.2	220	...	1.7	18213	6061452
Coalinga crude	.949	17.5	185	0.2	1.2	18990	6304680
Crude oil	.9485	17.6	155	0.2	3.5	18553	6159596
Crude oil	.9394	19.03	90	...	7.4	18412	6053681
Crude oil	.9192	22.3	78	0.75	7.0	18923	6083933

Table No. 1.

The relative values of the oils from different districts, and those of different specific gravity is a matter that often causes discussion. Those who have light oils to sell maintain that a pound of their oil has greater heat value than the heavier oils. This as a rule is true, but as oil is bought by volume instead of weight, a barrel of the heavier oil may contain as many heat units as the lighter oil. Specific gravity bears no necessary relation to the heat value, as oils of the same gravity vary considerably in heat units.

In table No. 1 will be found the physical properties and the heat values of various oils, so that the reader may draw his own conclusions. All determinations on these samples were made in the writer's laboratory.

From these data it is seen that we have two kinds of oil fuel—one in the natural or crude state, the other which has been treated in the refinery. The quality and physical properties of the former are more liable to vary. The gravity and heat value have a wide range, and the water contained is considerable. In many instances the writer has found as high as 10% of water in crude oil sold as fuel. The average is between 3 and 6%.

On the other hand, when oil is treated it is heated in the still to a temperature much above the boiling point of water. The water in the oil passes over with the distillate, leaving a moisture free oil to be used as fuel.

(To be continued.)

TRACKLESS TROLLEYS IN AUSTRIA.

A number of letters having been received asking for information regarding the trackless trolley lines in operation in Austria, Vice-Consul-General R. W. Heingartner of Vienna has gathered the following facts:

The Stoll trackless trolley system is the invention of Herr Ludwig Stoll of Vienna, a leading official of the Austrian Daimler Motor Company. The system has for some time been worked successfully near Vienna and elsewhere in Austria-Hungary. Current is taken from the overhead positive wire by flexible cables, and not by a pole or boom. Instead of an underrunning wheel or overrunning shoe, the head or actual current collector is a frame with two small grooved wheels on each side. One pair of wheels runs on the positive, the other on the negative wire, and the cable is suspended from the center of the frame, from which point also is suspended a weighted pendulum, which keeps the wheels well pressed down on the wires. The wheels (or pulleys) run on ball bearings. The trolley runs without sparking. The pull of the cable acting on a very short lever arm, and the center of gravity of the trolley being low, no deviation of the trolley is possible, even in strong transverse pulls. The conducting cable can be lengthened to follow the car by two appliances—an upper sliding knot tied up on the pendulum weight and stretched by a string in the latter, and a cable roller (on the left) with 10 to 12 yards of cable, which can be rolled up or let out by a spiral spring. Thus the car is allowed to run on any part of the road, to overtake other carriages, or to turn anywhere, accommodating itself to all kinds of traffic.

When two cars running in opposite directions meet, the drivers interchange the trolley conduits by detachable contact boxes, an important advantage over a tram line with one track, on which the loss of time in waiting at passing places is sometimes considerable. The vehicle having this flexible means of taking the current can, it is stated, move as far as 20 meters (65 feet) away from the wire, and thus has powers of adaptability which would be rarely exercised to the full extent.

The chassis of the vehicles for transport of passengers or goods is made of pressed steel and is supported on the axles by springs. The brakes act on the back wheels. The electrical part comprises a controller of tramway pattern, resistances, and two motors of 20 horsepower each, which really form an integral part of the driving wheels themselves on the Lohner-Porsche principle. There are no other mechanical parts of control or transmission; it is, therefore, very simple. Hardly any lubrication is required, all the parts of the wheels and motors running on ball bearings. Further, the elasticity of the vehicle itself is considerable, as the springs support only the chassis, the body, and the passengers, but no engine, batteries, or transmission gear, there being none of these mechanical complications. The suspension, therefore, is perfect, and notwithstanding the imperfections of the road, gives the impression of moving on rails. Vehicles carrying 3000 kilos (6600 pounds) and over have back wheels with iron tires. The cable transmitting the current passes through the interior of the axle. The armature of the motor is fixed by means of keys on the axle itself, and so acts as the nave of the wheel. The rest of the wheel is mounted on an ordinary motor on ball bearings, and is completely protected from dust. The cover serves to hermetically close the motor, as well as to fix it on the axle. Solid rubber tires are fitted to absorb the inequalities of the road.

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Changes of advertising copy should reach this office *ten days in advance of date of issue*. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
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Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
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CONTENTS

Electricity in Mining

Of all the multifarious uses to which the greatest modern servant of mankind—electricity—has lent itself, there are probably none more productive of greater economies, conveniences and factors leading towards human safety than is its application to mining.

In its subtle, silent way, electricity has invaded every realm of the miner's kingdom and has superseded him with his clumsy hand tools and slow, laborious methods. While it is true that this supersession has not, as yet, become universal, nor is it in all its applications entirely successful, still the operation of the modern mine has become so dependent upon the electric current that the mine which at the present time does not utilize it in some form seems a relic of antiquity.

The electric drill, while at the present time not an acknowledged success, is far ahead of the old four-pound hammer with its companion, the sunflower-headed hand drill, while electric ignition of blasts has removed the great element of risk to human life so often accompanying the old cap and fuse method. The patient, plodding mule has given way to the electric locomotive; the squeaking windlass or circling whim to the hoisting motor.

The old steam-driven Cornish pumps are supplanted by the modern high-speed motor-driven multi-stage centrifugal; the time-honored candle in the miner's cap to the incandescent bulb; the grinding arastra, or shaft-driven stamp mill, have submitted, the one to obsolescence, the other to unification and subdivision.

While not superseding a former procedure, the intercommunicating telephone has reduced delays and exasperating mistakes, to say nothing of the increased safety it affords those underground.

In the present article on the subject, by Mr. Shoemaker, we are ably introduced to the myriad points and kinks which are gained only through years of experience in adaptation. Indeed, the paper affords much of the "unwritten law" of this branch of engineering.

It is rare that one in the possession of such a fund of practical knowledge on a subject can be induced to transmit it so fully to his fellow-engineers. May the example of Mr. Shoemaker inspire many others possessed of the "secrets of the trade" to the same philanthropic action.

Building up the Coast Region

All the Pacific Coast needs to increase in prosperity, population, production and industry, is to make its resources known to all the world in the right way. The Pacific Coast will increase vastly within the next decade, and within a few decades will surely outstrip the Atlantic Coast in everything that goes to make up modern business and civilization. Doubtless in the Pacific States region, and at no distant date, the greatest Anglo-Saxon settlement that the world has ever known will have found an abiding place and scope for its indomitable energies. The supremacy of the commerce of the Pacific involves nothing detrimental to the prosperity of the Atlantic Coast, and indeed will accentuate the progress and that of the whole United States.

WESTINGHOUSE NEW VICE-PRESIDENT.

Mr. Henry D. Shute was appointed to the position of acting vice-president of the Westinghouse Electric & Manufacturing Company as of April 1, 1910.

For seventeen years Mr. Shute has been associated with this company, and his promotions from time to time have been of a character to give him a broad experience in shop, sales and executive work.

Mr. Shute studied electrical engineering at the Massachusetts Institute of Technology, from which institute he was graduated in 1892. Following his graduation, he spent a year's study in Germany at the School of Mines, Clausthal, and also in Dresden. It was in 1893 he entered the works of the Westinghouse Company at Pittsburg as an apprentice, spending his first two years in the testing department, following which he spent considerable time on erection work,

Henry D. Shute.

on laboratory work, under Mr. C. F. Scott, and later as assistant foreman of one of the departments of the works. This naturally gave him a broad experience in shop work, which, with the designing work on alternating current apparatus which he subsequently took up in the engineering department, enlarged his experience still more.

After five years' service with the company, Mr. Shute took up work in connection with the sales department at the East Pittsburg office, and in 1901 was made the head of the alternating current division, correspondence department. Two years later he was advanced to the position of assistant to Vice-President L. A. Osborne, which position he held at the time of his recent appointment. In this latter position he was active in the developments made in heavy electric traction and particularly in single-phase railway work.

Mr. Shute is a member of the American Institute of Electrical Engineers; a member of the Engineers' Club of New York, and most of Pittsburg's business and social clubs.

TRADE CATALOGUES.

The Fort Wayne Engineering & Manufacturing Company, Fort Wayne, Ind., have issued a bulletin describing the Paul pneumatic pressure system of water supply, giving description of direct-connected motor-driven pumps. The application of this system includes residences, hotels, fire-protection service, water-softening plants, etc. The bulletin is entitled "Pumping Machinery," and can be obtained from any of the offices of the Fort Wayne Electric Works.

PERSONALS.

A. G. Wishon of Fresno, who has electric power interests in Southern California, is a visitor in San Francisco.

Sidney Sprout, electrical engineer, has just returned from a business trip to Los Angeles and surrounding territory.

Thomas Collins of the Westinghouse Electric & Manufacturing Company's sales force is making a trip to Eureka.

W. H. Hill, who is interested in the Monterey County Gas & Electric Company of Monterey, was a recent visitor in San Francisco.

W. J. Davis Jr., Pacific Coast engineer for the General Electric Company, recently returned to San Francisco after visiting the Schenectady factory.

H. G. Stott of New York, who has been in Los Angeles on electrical engineering business, passed through San Francisco last week on his way East.

W. S. Heger, Pacific Coast manager for the Allis-Chalmers Company, left San Francisco last week on a short business trip to the factory in Milwaukee, Wis.

Thomas Mirk, of Hunt, Mirk & Co., representing the Westinghouse Machine Company on the Coast, has gone to Los Angeles on steam turbine business.

R. Husbands, manager of Pierson, Roeding & Co.'s Seattle office, returned to Puget Sound during the week after visiting the main office of the firm in San Francisco.

H. D. Boschken, manager of the California Electrical Construction Company's San Jose branch, visited the main office in San Francisco during the past week.

Edward G. Dewald of the San Francisco office of the Allis-Chalmers Company left for the Pacific Northwest last week on business with the hydraulic turbine department.

H. P. Wilson, secretary of the Great Western Power Company, arrived in San Francisco from New York during the past week on important business connected with local banking interests.

W. J. Krase, erecting engineer for the Pelton Water Wheel Company, is at Gateway, Utah., in connection with the installing of the new hydro-electric plant of the Utah Light & Railway Company.

Mr. Herbert Rice, general sales manager The Cutter Company, Philadelphia, was in San Francisco last week on his annual visit to their agencies throughout the West. He left for Portland Thursday.

A. L. Bell, a son of Professor Alexander Graham Bell, inventor of the Bell telephone, and S. F. B. Morse Jr., a son of Professor S. F. B. Morse, the father of telegraphy, recently visited San Francisco.

C. A. Coffin, president of the General Electric Company of New York, has returned to Southern California after spending a few days in San Francisco as the guest of Doctor Thomas Addison, the district manager.

C. L. Cory has returned from a trip to Santa Barbara in connection with his report to the municipality as to the cost of producing gas. He is now working on a similar report in connection with fixing the rates for electric light and power in Santa Barbara.

W. B. Southwick, who is manager of the United Wireless Telegraph Company's Seattle office, has returned to Puget Sound after spending some days in San Francisco in connection with the installing of wireless apparatus on steamers of the Pacific Mail Company.

E. A. Davis of New York, who is a guest at the Fairmont Hotel, is credited by local publications with representing the Continental Trust Company of New York in successful negotiations for the purchase of the control of the Key Route electric railway and ferryboat system connecting Oakland and Berkeley with San Francisco.

INDUSTRIAL

BOILER FEED REGULATION.

Progress in mechanical industries has been closely allied with the invention and perfection of automatic devices of all forms. In the railroad field, we find that heavy freight traffic and high-speed passenger service was made possible by the air-brake. Among the improvements in stationary steam plants the automatic governors have probably contributed more toward reliable operation and increased output, than any other single device. In the electrical field, proper, we find automatic voltage regulators, circuit breakers, and other devices which not only make operation more reliable and safe, but cut down the cost of attendance.

It would thus seem that inasmuch as the boiler is primarily the seat of power in any plant, it should be equipped with the best and most up-to-date automatic devices. Next to the safety valve, with which all boilers are equipped, it appears that the next step in the line of progress should be the installation of apparatus which will insure a constant water-level in the boiler under all conditions of operation. Then, again, the increasing demand for higher steaming capacity, conservation of fuel, and reliable service necessitates that the rate at which water is fed into a boiler be equal to the rate of evaporation. This necessity for constant water-level has been realized by progressive engineers and is ably summed up by Prof. Kent, as follows:

"Steadiness of water-level requires either a large area of water-surface and volume of water, so that the level may be changed slowly by fluctuations in the demand for steam or in the delivery of the feed pump, or else constant and preferably automatic regulation of the feed water supply to suit the steam demand. A rapidly lowering water-level is apt to expose dry sheets or tubes to the action of the hot gases, and thus be a source of danger. A rapidly rising level may, before it is seen by the fireman, cause water to be carried over into the steam pipe, and endanger the engine."

The advantages of automatic regulation of boiler feed and the maintenance of a constant water-level may be briefly summed up as follows:

1. The boilers are insured against low water and all danger of bagging and burning of tubes or boiler plates is practically eliminated.

2. The heat saving economies of feed water heaters and fuel economizers are greatly augmented as the flow of water through them is maintained about equal to the amount of waste heat furnished to them. This point is clearly brought out by the two charts shown herewith from which it will be noted that the average temperature of the feed water after the installation of an automatic boiler feed regulator is considerably higher than it was before. This is due to the fact that as a load comes on the plant and consequently the engine is exhausting more steam into the heater, there is of course a correspondingly greater demand on the boiler, and as the feed water regulator is very sensitive it immediately opens the feed valve increasing the flow of water to the boiler and through the heaters. Thus, every time there is an excess of steam blown into the heater there is also an additional quantity of the water passed through into the boiler.

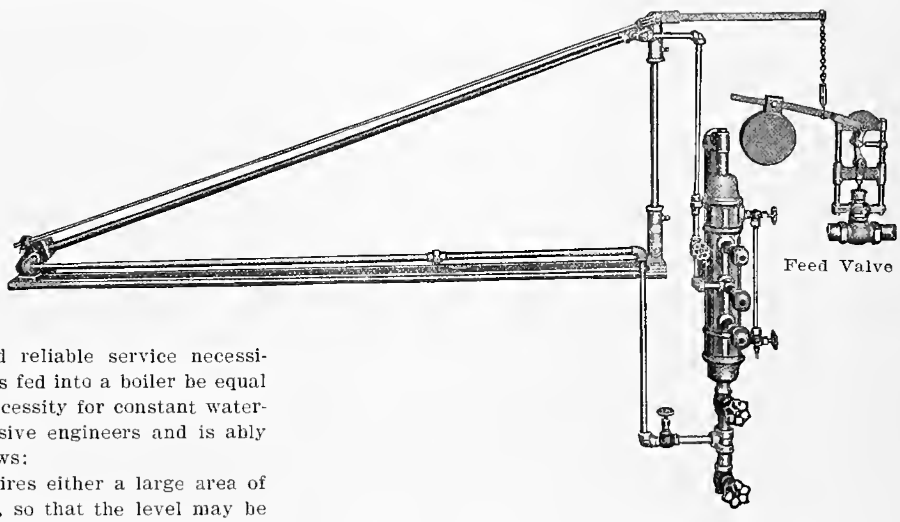
3. The danger from priming is greatly reduced, thus saving cylinder lubricant and lessening the frictional wear between valves and seats, and piston and cylinder, due to the better lubrication possible with dry steams.

4. The life of turbine blades is greatly increased as errosion due to wet steam is eliminated.

5. Superheaters have higher efficiency as they are supplied with dry steam and their only duty becomes that of superheating, also scale-forming materials are prevented from being carried over into them, thus eliminating the cost of cleaning.

6. Operating expenses are greatly reduced as less boiler room attendance is required. All the fireman has to do is to fire, his attention need not be distracted by watching the water gauge.

Copes Boiler Feed Regulator attached to the water column of a boiler. The Regulator may be placed at any distance from the boiler by using longer connecting pipes. The feed valve may also be at any distance from the Regulator, but the eye of the toggle arm must be directly below the outer eye of the upper regulator arm, that is, the chain must occupy a vertical position.

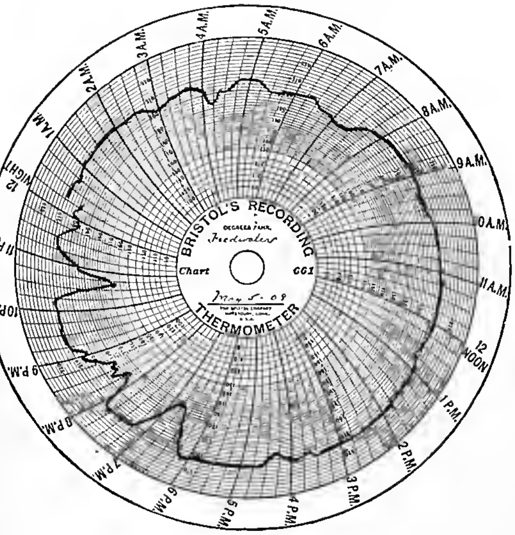


The Copes regulator, which is illustrated in Fig. 2, has ingeniously adapted the principle of expansion and contraction of metal, under the influence of heat to the control of a boiler feed valve. As can be seen, the device is simple in its construction and is completely external to the boiler. The expansion member, consisting of a copper tube, is at one end in communication with the point on the water column corresponding to the desired water-level in the boiler, and at the other end to any convenient place below the water-level. Thus, when the water in the boiler is low the expansion tube is filled with steam, and when the water in the boiler is high, the expansion tube is cut off from the steam supply and as the steam within it condenses, due to radiation, it fills up with water. When steam is in the tube, there is a continual supply of heat and therefore the tube is kept at a temperature equal to that of the steam. When the steam supply is cut off, however, the tube is filled with water, which, by giving up its heat to supply radiation losses, experiences a temperature drop which causes the tube to contract, operating the feed valve mechanism.

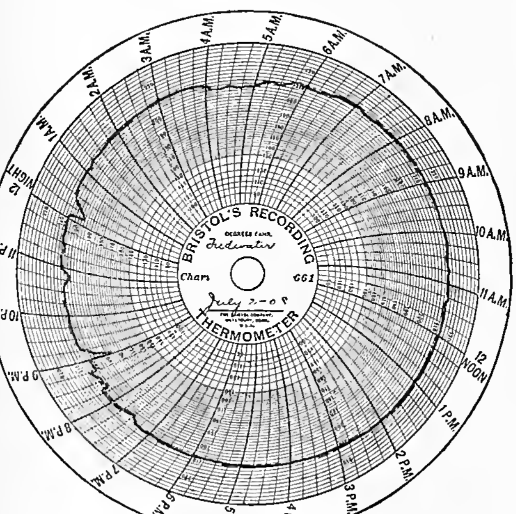
The regulator tube might well be compared to a common steam radiator, which, even in the coldest weather, does not cool off so long as the supply of steam is continual. However just as soon as the valve is shut off and the steam allowed to condense, the radiator cools off. When the Copes tube is

full of water, there is some circulation, but this is nowhere near fast enough to make up for the radiation loss and keep the tube hot. This has been proved by experiment many times.

While this motion, due to expansion and contraction, is positive and reliable, it is not sufficient to actuate the feed valve directly. For this reason a very simple system of levers magnifies and transmits this motion to the feed valve. As can be seen by reference to the figure, the expansion of the tube operates a bell crank lever, which, in turn, lifts a weighted lever by means of a chain, thereby actuating a toggle joint which permits an ordinary check valve to open.



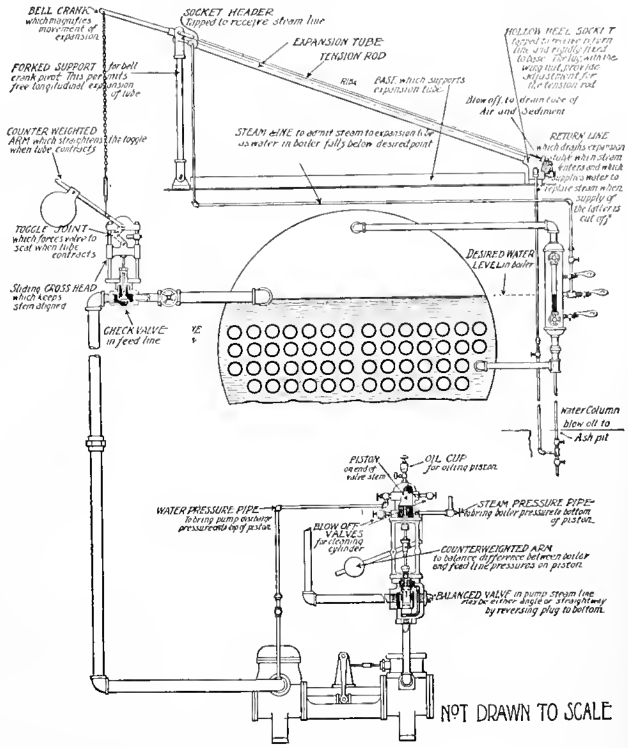
Showing daily variations, in the temperature of boiler feed water from Cochrane Heater, due to irregularity of feeding, before Copes Regulator was installed.



Showing uniformity of feed water temperature after Copes Regulator was installed to hold inflow of feed just equal to evaporation at all times. Increased area of chart represents coal saved. See page 13.

The action on contraction is the reverse, that is, the chain slacks off and the feed valve is closed by the weight. It is to be noticed that the valve employed is in every respect a check valve, as it is not permanently connected to the valve stem of the regulator. In fact, this valve is accepted by boiler inspectors in place of the ordinary boiler check valve.

It is interesting to note that the Copes regulator requires no auxiliary water columns, or float chambers, neither does it necessitate the boring of holes in the boiler shell, in fact the work of installing this regulator requires only a small amount of pipe fitting which can be done in a short time.



There is only one packed joint and that is at the valve stem, hence there is no danger of leakage and as no floats or diaphragms, which are liable to collapse, or piston or pilot valves, which cut out due to wire-drawing, are used, the whole apparatus is extremely simple and reliable.

The Copes regulator is manufactured by the Northern Equipment Company of Chicago, Ill., the general Pacific Coast agents being Chas. C. Moore & Co., engineers, of San Francisco.

SAN FRANCISCO ENGINEERS HOLD ANNUAL BALL.

On Saturday evening, April 2d, an enjoyable affair was participated in by a large number of San Francisco engineers and their wives and families. The event was the first annual ball given under the auspices of the N. A. S. E. of San Francisco, and as the committee in charge was composed of the former Fair and State Convention Committee of 1909, five members being appointed from each of the two subordinate associations, California No. 1 and No. 3, it could not be otherwise than a grand success. The ball was held in the Auditorium Annex, which was comfortably filled and the dancing was continued until 1 a. m.

Director John W. Carter acquitted himself of his arduous duties ably, as did all the other members of the committee, assisted by the floor committee. Charley Elsasser, the versatile, even wresting the baton from the genial Prof. Ehrman and conducting the orchestra while playing a rollicking two-step, which was punctuated by the accompaniment of a number of shots from a blank cartridge pistol, which made some of the thirsty ones at the refreshment stand think that a gauge glass had broken.

Many of the throttle wielders had not done a stroke of dancing in twenty years, but they were game, and covered themselves with glory, likewise perspiration. Bro. John

Traynor never missed a number despite his decrepitude. The bunch, as is their usual custom, congregated in close proximity to the bar, and swapped Sunday school story reminiscences and drank pink lemonade.

The feminine portion of the gathering were well pleased, as no cold feet were discernible among the engineers; every one, old and young, doing their best to see that no ladies sat out any of the dances, and when Prof. Ehrman laid down his baton after playing "Home, Sweet Home," everyone conceded that the affair was thoroughly enjoyable, and hoped the committee would take steps to make the affair an annual one.

Bro. Phil Ennor, President of California No. 1, in his usual happy manner, addressed the audience and explained the object of the ball, which was to bring the families of the members together, and thus cement the feeling of goodfellowship and fraternity which exists between the members of California No. 1 and No. 3.

Among those present were the committee of arrangements; Bro. B. E. George, chairman; J. W. Carter, John Traynor, C. C. Elsasser, W. M. Jenkins, John W. Maher, W. T. Bonney, J. L. Davis, Charles Dick, treasurer, and H. W. Noethig, secretary.

Floor Committee—John Carter, director; A. C. Arbuckle, J. B. Williams, Clyde D. Johnson, David Thomas, Frank Tuttle and J. G. De Remer.

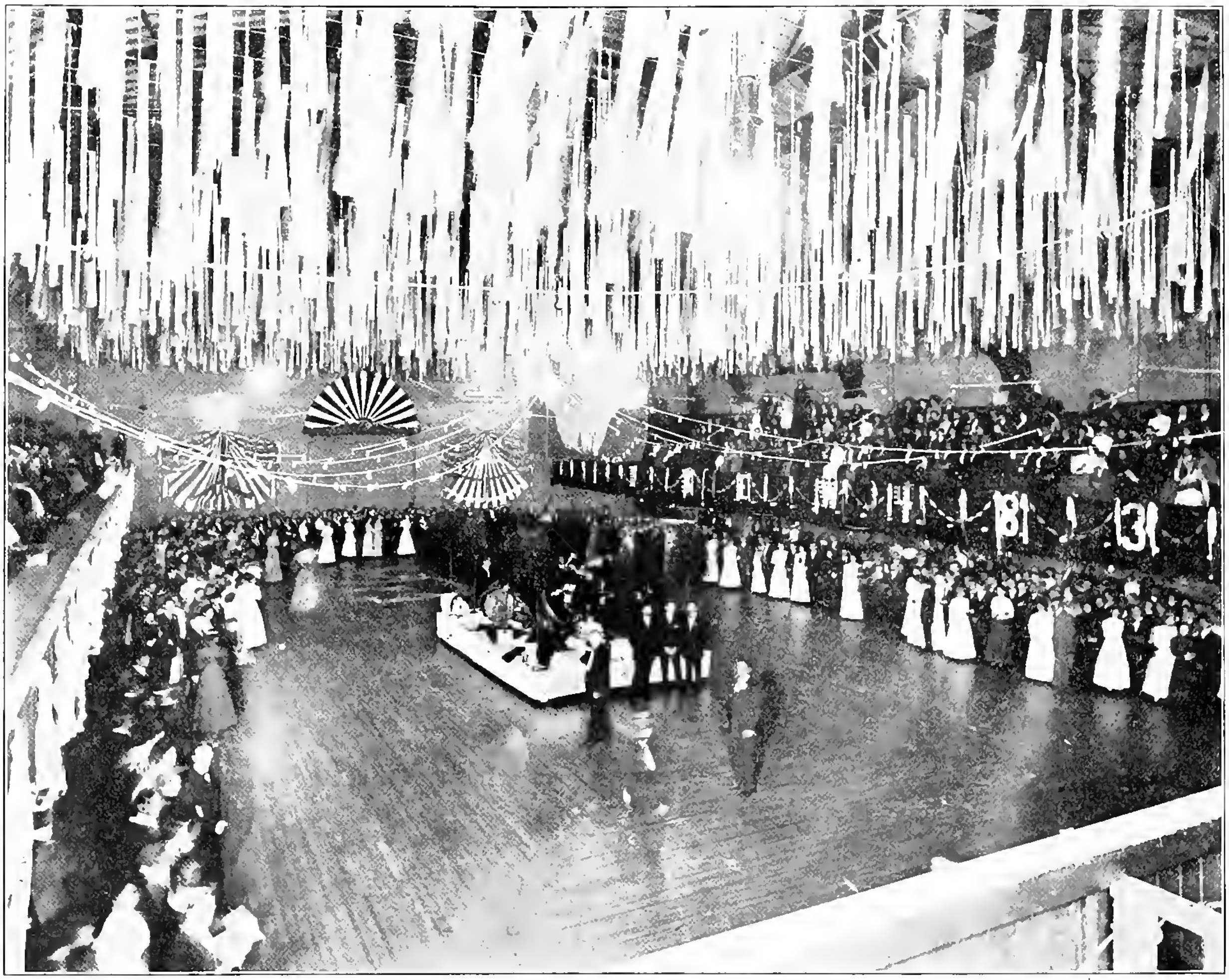
Bros. W. P. Millner, H. D. Saville, James B. Castle, Dan Daniels, J. Richards, L. W. Holbrook, C. E. Van Meter, W. N. Munro, J. B. Green, Charles Knights, P. Reardon, M. Nelson, J. Ostrom, W. T. Carroll, J. Gaskill, Alex McDonald and a host of other engineers and friends, too numerous to mention. Almost all were accompanied by their wives or some other engineer's wife and all voted that the affair was the most joyous in the annals of the N. A. S. E. in San Francisco.

DAVID THOMAS,
Recording Secy. Cal. No. 3, N. A. S. E.
439 Merchants' Exchange Bldg., San Francisco, Cal.

ELECTRICAL WORKERS' BALL AT TACOMA.

The accompanying illustration was taken at the third annual ball given by Local 483 of the International Brotherhood of Electrical Workers, at the Armory, Tacoma, Wash., March 17, 1910. This was one of the largest balls ever held in that city, the attendance being about 4000.

The illumination consisted of eight Grant flaming arcs having a c.p. of 40,000; 1000 16-c.p. incandescent lamps festooned as shown in the photograph, and two spot lamps. At the north end of the hall were a 6-ft. star and a 9-ft. anchor outlined by means of incandescent lamps. Between the anchor and the star was a set piece representing the sun rising over hills. To the right of the anchor was a moving picture machine which threw the dance numbers upon the canvas. Along the right-hand balcony was outlined by means of incandescent lamps "I. B. E. W.—483"; along the left-hand balcony outlined in the same manner, "Welcome." At the end of the hall, not shown in the photograph, were the spot lamps, a set piece 4 x 6 ft. representing the American flag and a flasher showing the emblem of the I. B. E. W. The color scheme was green and white. The green and white crepe paper suspended from the beams together with tinsel cord about every 4 ft. made quite a pleasing effect. The committee on decorations consisted of J. T. Riley (chairman), George Osborn and S. V. Peterson.



I. B. E. W. Ball at Tacoma, Wash.

SOUTHERN CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Special Correspondence.

A special convention of the American Institute of Electrical Engineers was held in Charlotte, N. C., March 30th and 31st and April 1st. This is the first of a series of conventions or meetings which, it is hoped, will be held in different sections of the country from time to time, but which are not intended to take the place of the annual conventions.

Headquarters were at the Selwyn Hotel and over three hundred visitors, members and guests were registered, altogether, about 550 names being on the list of those in attendance.

The first meeting was held at 2:30 p. m. Wednesday. After being warmly welcomed to Charlotte by Mayor T. W. Hawkins, who was thanked, on behalf of the Institute, by President L. B. Stillwell, a paper on "Electric Drive in Textile Mills" by Albert Milmow was read.

In the discussion, in which C. F .Scott, W. S. Lee, A. W. Henshaw and D. B. Rushmore took part, it was pointed out that the greatest gains from the electric drive are usually incidental; that is, the improved steadiness of the drive, which permits of a higher speed with improved quality of product and increased output, are more important than reduced cost for power. The curves given in the paper bring this feature out clearly. Moreover, the electric drive is flexible and makes possible the best arrangement of the machines without respect to the driving power. Also, extensions are easily made. The function of the electric service is the supplying of power, and in general it is better for the mill to buy its power, as it does its other supplies, than to make it.

E. D. Latler Jr. read a paper entitled "Gas Engines in City Railway and Light Service." There was no discussion on this paper. After the meeting visits were made to various textile mills and to the gas engine station described in the above paper.

Wednesday evening E. E. F. Creighton gave an experimental lecture, illustrating the characteristics of various types of lightning arresters.

Thursday morning the second session was held, when Carle Hering read abstracts of his paper on "The Proportioning of Electrodes for Furnaces," and of Dr. A. E. Kennelly's paper on "Modifications of Hering's Laws of Furnace Electrodes." Mr. Hering discussed briefly Dr. Kennelly's paper and read a short discussion thereon.

W. S. Lee read a paper entitled "Economies of Hydroelectric Plants." This paper was discussed by C. E. Wachdell, P. H. Thomas, C. Hering, E. W. Shedd, L. B. Stillwell, W. L. Waters and R. W. Pope. It was pointed out that power companies should have the right of eminent domain, now enjoyed by railroads; that one large system gives better service than several smaller ones Certain utilities are natural monopolies and the public should be educated to recognize them as such; unjust rates can be prevented by the State, which now has that right. It was suggested that a night load might be built up if electric roads should be built upon which freight might be hauled after the mill load has gone off. It was suggested that the induction generator would be a suitable machine for systems where many stations are operated in parallel, the magnetizing current for these machines being furnished by the charging current of the line. There are a number of electro-chemical and metallurgical processes which could profitably use the intermittent overflow power of hydroelectric systems.

Thursday afternoon L. C. Nicholson read a paper entitled "A Method of Protecting Insulators From Lightning and Power Arc Effects With Results of Its Installation on the Lines of the Niagara and Lockport Power Company." This paper was discussed by P. H. Thomas, J. W. Fraser, E. B. Merrian, C. F. Scott, J. A. Sanford Jr. and others. It was suggested that one possible means of overcoming most of the insulator troubles would be to increase the factor of safety. This method had cured transformer troubles. The disadvantages of short interruptions should not be magnified. The ground wire had not yet been proved valueless and two ground wires would be better than one as lightning at times comes in from the side.

Written communications were received from Professor Harris J. Ryan, James Lyman and S. V. Brooks, but were not read due to the latness of the hour. Professor Ryan suggested shields and barrier plates to prevent damage to the line when an arc occurs.

During Thursday afternoon the visiting ladies were entertained by Mrs. Stuart W. Cramer, and in the evening a brilliant reception and dance were given at the Auditorium.

Friday was given up to a trip to the Great Falls and Rocky Creek stations of the Southern Power Company, the Institute being the guests of the company. A special train carried the party of 400 to the power sites and after the inspection an old-fashioned barbecue was given the company. H.

TRADE NOTES.

The People's Light & Power Company has just secured its franchise for Alameda county on a bid of $100, the threatened opposition not having materialized. The Great Western Power Company's current will be distributed by this concern through portions of the county outside of the city of Oakland, including Fruitvale, Elmhurst, San Leandro and Haywards.

R. S. Buck, a member of the firm of Sanderson & Porter, has just arrived in San Francisco from New York. He expects to make quite a stay here in connection with the completion of the Sierra & San Francisco Power Company's Stanislaus river development. The announcement of the starting up of the fourth 6750-kw. generating unit, at the main power plant near Vallecito, is expected soon. M. C. McKay, the station superintendent, has been installing the new equipment.

Carl Bauer, one of the turbine wheel designers from the Pelton Water Wheel Company's New York office, is now at Gateway, Utah, supervising the installation of the 5000-h.p. Pelton-Francis turbine for the Utah Light & Railway Company. This is a new auxiliary plant located about fifteen miles from Ogden and it will tie in with the Salt Lake system. The new water wheel will be direct connected to a Western Electric generator and will operate under a head of approximately 138 ft. at 300 r.p.m. A Pelton oil-pressure governor, of Pelton type, will be used.

The General Electric Company has sold to the Sierra & San Francisco Power Company, in connection with the extensive changes in the United Railroads system in San Francisco, a 9000-kw. (maximum rated), 60-cycle vertical steam-turbine generator with condenser base. It will be installed in the United Railroads' North Beach power station. The present 5000-kw. steam-turbine set at the United Railroads' North Beach station will later have a new generator installed, with a maximum capacity of 9000 kw. This load can be carried continuously.

The largest contract for mining and ore-reduction machinery let since the panic has just been closed by the Allis-Chalmers Company, through its London office, with the Union Miniere du Haut Katanga of Brussels, Belgium. This comprises every detail of the crushing, concentrating and smelting equipment for a copper-producing plant of 900,000 tons yearly capacity, including power house and electrical equipment to be built near Lake Tanganyika in the Congo territory of central Africa. This order, which covers one of the largest and most perfectly equipped mining plants in the world, was obtained in a wide competition because of the unique ability of an American company to supply all the machinery under a single contract.

NEWS NOTES

FINANCIAL.

PORTLAND, ORE.—Fire Chief Campbell and Engineer D. D. Clarke, of the Water Department, are considering plans foi the expenditure of $275,000 bonds to be sold in providing for a fireboat and re-enforcing water mains for the protection of the business district.

FRESNO, CAL.—Sealed bids will be received by the Clerk of the Board of Supervisors up to 11 a. m., April 23, 1910, for the sale of a franchise for a street and interurban railroad over, along and across certain streets and highways in Fresno County. The application was made by the Fresno Traction Company.

SAN FRANCISCO, CAL.—W. R. Hagerty, Clerk of the Supervisors, has received word from Dillon & Hubbard, the New York attorneys who haxe examined former bond issues for the city, saying that they will examine and pass upon the validity of the $45,000,000 proposed water bond issue for the snm of $20,000.

EL CENTRO, CAL.—The City Council passed an ordinance providing for the issuance and sale of the interest bearing bonds of the city of El Centro in the amount of $69,000, for the purpose of the acquisition, constructing and completing of a municipal water works and water system for supplying water to the city.

INCORPORATIONS.

SEATTLE, WASH.—The Bothell Electric Company, of Seattle, Wash., with a capital stock of $25,000, has been incorporated by C. W. Kimball, W. A. Garlick and A. R. Rutherford.

BAKERSFIELD, CAL.—The Twenty-three Water Company, with a capital stock of $10,000, has been incorporated by T. M. Young, B. L. Smith, J. B. Wrenn A. B. Canfield and A. L. Cheney.

BAKERSFIELD, CAL.—The Horton Electric Company, with a capital stock of $75,000, has been incorporated by J. B. Murdock, J. W. Ragesdale, C. C. Painter, R. E. Woods, H. E. Smith, J. A. Felter aud A. A. McCumber.

STOCKTON, CAL.—The Stockton Terminal and Eastern Railroad has been incorporated by A. Shane of Indianapolis, W. H. Newell of Stockton, A. A. Grant of Sonora, M. J. Congdon, J. E. Adams and R. V. Dixon of Berkeley, and others.

ELLENSBURG, WASH.—The Ellensburg Oil & Gas Company has been incorporated by P. H. Ross, B. A. Gault, F. P. Wolff and Geo. R. Simpson, with a capital of $1,000,000. Work of drilling for oil on the old Bull ranch, near Thrall, will be resumed at once by the new company.

SACRAMENTO, CAL.—The California Northern Telephone and Telegraph Company, to operate in all parts of Northern California, has filed articles of incorporation. It is capitalized at $100,000 and the following are the directors: Scott Hendricks, San Francisco; W. H. Bissell, Livermore; W. E. Ellis, Arthur Mathews, Grant Smith, M. C. Colby and J. O. McElroy, all of San Francisco.

ELLENSBURG, WASH.—Articles of incorporation have been filed by the South End Water Company, with a capital of $12,000, with the principal place of business in this city. The objects of the company are to construct, operate, equip, maintain and renew a system for the supply of water to such parts of Ellensburg and the territory adjacent as it shall obtain franchise for. The incorporators are Geo. DeWees, Cbas. Anderson and J. W. Gilliam.

TRANSMISSION.

SAN BERNARDINO, CAL.—The Edison Power Company is hauling many tons of cement into the Santa Ana Canyon, for repairs on the flumes and powerhouses damaged by the storms of the late fall. The company will also build a new power plant at Slide Lake, in the canyon, and $600,000 will be expended in this improvement.

ADIN CAL.—R. Perrault has filed on 5,000 inches of the water of Ash Creek, running from Ash Valley, in Lassen County, to Big Valley, in Modoc County. There is abont a 600-ft. fall in about ten miles. This location has been chosen for a pipe line for electric power purposes, the power to be used at the Hayden Hill Mines, about six miles distant.

CHICO, CAL.—The Great Western Power Company will not this year construct the projected storage reservoir in Big Meadows. This statement is made by A. B. Bidwell, superintendent of the Big Meadows division of the power company. Superintendent Bidwell added that his company will take up the matter of establishing permanent headquarters in Big Meadows. The temporary headquarters have hitherto been at Bunnell's place, near Prattville. The new and permanent headquarters will be situated at the east end or ontlet of the valley, at a point that has been known as Meadow View, but which will in the future be known as Nevis. The improvements at Nevis will consist of the restoration of the hotel and other buildings and the installation of a water system. As Nevis is the nearest point to the Western Pacific, as well as to the main construction work to be completed later on the new headquarters will be a place of considerable business importance. The construction work of the power company is now centered on the big dam near Big Meadows. The ontlook is that the construction of the Big Meadows project will be long delayed, as the company has three sites along the North Fork of the Feather River, above Big Bend. These will probably be developed before the Big Meadows plans are carried out.

ILLUMINATION.

ORLAND, CAL.—The Northern California Power Company will soon start to build a sub-station on C. F. Hale's ranch for the power line which is to tap the company's Orland-Hamilton branch line.

GRANGEVILLE, IDAHO.—The Council has passed an ordinance granting a 30-year franchise to Walter Hovey Hill for the use of the streets and alleys of the city for the purpose of stringing wire over which to transmit an electric current.

MEDFORD, ORE.—The City Council has granted a 25-year gas franchise to J. R. Anderson, of Pasadena, for the erection of a gas plant in Medford. The plant is to be in operation within eight months from the date of the granting of the franchise.

PORTLAND, ORE.—According to information given out by C. E. Grosbeck, of San Diego Cal., vice-president of H. M. Byllesby & Co., of Chicago, five million dollars will be expended on improvements by the company to its northwestern gas, electric and telephone systems.

SAN LUIS OBISPO, CAL.—C. F. Hoffman has presented to the Board of Supervisors his application for a franchise for the term of 50 years, to lay gas pipes for the purpose of carrying gas for heat, light and power over and upon public highways in San Miquel Judicial Township in San Luis Obispo County. Sealed bids will be received by the Board of Supervisors up to 10 a. m. May 3, 1910, for the sale of this franchise.

LOS ANGELES, CAL.—The City Council passed an ordinance ordering necessary appliances to be installed and electric current to be furnished for a period of one year for the lighting of Pico street, between Main and Vermont avenue.

SIERRA MADRE, CAL.—The City Council passed an ordinance granting to C. S. S. Forney a franchise to construct, operate and maintain for a period of 50 years an underground conduit, mains and gas pipes in the public streets, for the purpose of conducting and carrying gas for light, heat and power.

NORTH YAKIMA, WASH.—E. Storer Tico, local manager of the Northwestern Corporation in North Yakima, has announced that the sum of $40,000 is to be expended by the company in doubling the size and capacity of the local gas plant and, in addition, about 12 miles of mains in the territory not now served with gas. New and enlarged machinery will be installed in the plant, new branches will be placed and new retorts erected. There will also be new compression tanks.

TENINO, WASH.—The Tenino Light, Power & Water Company is prepared to construct a dam and powerhouse, with an output of 2,000 hp., on the Skookumchuck River, 15 miles east of Tenino. The project calls for the expenditure of $200,000. Water will be transmitted to the turbines through a wood pipe 60 in. in diameter and 3,0007 ft. long, to have a fall of 174 ft. The dam will be built of concrete, reinforced with steel rails. S. W. Fenton, of Tenino, is the president of the company.

LEWISTON, IDAHO.—Plans are being perfected for the organization of the Craig Light & Power Company, of Vollmer, with a capital stock of $50,000. The company has acquired a power-site on Lawyer's Canyon Creek, above the railroad bridge, and by moderate development will be able to generate 500 hp. Among list is a large machine shop that will be complete in every detail and will be equipped to handle all kinds of farm and milling machinery. Those interested are W. J. Ramoy, W. L. Lyons, J. Tyler and J. B. Davis all of Vollmer.

LOS ANGELES, CAL.—When the $40,000,000 Pacific Light and Power Company has completed its present plans for the rebuilding of the great Redondo Beach power plant, it will have one of the greatest plants of its kind west of Chicago. Ground will be broken this week, and the plant will be in operation by November 1st. More than $1,000,000 will be expended on the plant alone, while the distributing system throughout Southern California will be enlarged to the extent of $2,000,000. New engines will be installed and new turbines will go into present building, where pumps are in operation.

RICHMOND, CAL.—At the last meeting of the City Council Mr. Kline, of the Pacific Gas and Electric Company, said: "Our engineering department is busily engaged in getting out plans for a large distributing plant, to be constructed in your city at a cost of something like $75,000 or $100,000. We expect to proceed within 60 days with the work of installing this system and piping your city with mains for the distributing of gas. We propose to lay the mains so as not to interfere with the present improved streets. We are anxious for the co-operation of your citizens and in a short time will make a canvass of your town and endeavor to get a large patronage lined up. We propose to extend our distributing system to all parts of the town where the same will give us a reasonable return upon our investment. Your people will be highly pleased with our system and we are anxious for their co-operation." It is understood that the company will pipe the west side of town and supply all residence districts with the commodity.

LOS ANGELES, CAL.—The San Joaquin Light and Power Company, a subsidiary of Huntington's Pacific Light and Power Company of this city, announced Tuesday that it will at once begin the expenditure of $1,250,000 on a plant on the North Fork of the San Joaquin River, near Fresno, where a minor plant has been in operation several weeks. The larger plant will develop 22,000 hp. and supply light and energy to Fresno, Madera, Fowler, Hanford, Selma and as far south as Coalinga and the adjacent oil fields. The immediate work involves the construction of a dam 125 feet high, behind which will form a lake sixteen miles in circumference and an unfailing water supply to run the immense turbines. This is but a step on the part of the $40,000,000 Huntington corporation toward development in that section as a part of its comprehensive California power system. Five millions will be used in the San Joaquin region alone within the next three years.

TRANSPORTATION.

SAN FRANCISCO, CAL.—The Board of Works has denied the United Railroads' application for a permit to lay tracks, erect poles and string wires on Presidio avenue.

HILLYARD, WASH.—The Great Northern shops at Hillyard are to be enlarged this spring. Machine and car shops are to be doubled and the repair and store tracks increased.

VALLEJO, CAL.—Information received from Sacramento states that within the next ninety days gronnd will be broken for the extension of the Northern Electric from Sacramento to this city.

LOS ANGELES, CAL.—The City Council has voted to sustain the Board of Public Utilities in its protest against the city's offering for sale a franchise for a street-car line along San Pedro street from Aliso to Seventh.

HONOLULU, H. I.—The plans for the extension of several lines of the Honolulu Rapid Transit Company have been submitted to the Territorial Superintendent of Public Works, Marston Campbell. Tracks will be laid on Young street, between Alapai and Kapiollani streets.

SAN FRANCISCO, CAL.—The Supervisors have determined to defer consideration of the Bancroft bill to compel the United Railroads to run the Sutter-street cars down the inner rails of lower Market street until after the meeting of the Public Utilities Committee April 13th, the date set for the discussion of questions arising from the street railway situation in lower Market street.

SACRAMENTO, CAL.—Charging that the Santa Fe Railroad, instead of promptly delivering in Marysville fifty ballast cars turned over to the corporation in Detroit, Mich., for that purpose, filled the cars with merchandise and used them for its own purpose and for the benefit of its patrons, the Northern Electric Railway Company has begun suit for $20,544 damages. The cars were needed by the electric company in connection with the construction of its tracks between Chico, Marysville and Sacramento.

BELLINGHAM, WASH.—The final contract between the subscribers to the interurban fund and Stone & Webster, who agree to build an electric line between Bellingham and Sedro-Woolley, Burlington and Mt. Vernon, in Skagit County, has been drawn up in the office of Newman Howard and approved by the legal committee. The contract has been signed by Geo. Cooper, chairman of the committee and trustee for the Supervisors, and sent to the Stone & Webster representatives in Seattle for their signatures. It is now assured that work will be started immediately.

SAN FRANCISCO, CAL.—The San Francisco Suburban Improvement Company, a corporation with a $500,000 capital,

PROFESSIONAL DIRECTORY

has promised to build its proposed road if the residents of the Sunset District and others interested will subscribe the difference between the market and the par value of the bonds to be issued. The proposed route of the line would start in Parnassus avenue, at the end of the Masonic-avenue car line, to Third avenue, to J street, to Ninth avenue, to Pacheco street and Ninth avenue, a distance of one and one-half miles. The cost of the road is estimated at $80,000, and of this sum the San Francisco Suburban Improvement Company has subscribed $60,000. It is desired that the residents of the district subscribe the difference of $20,000.

EVERETT, WASH.—Eastern stockholders of The Washington Railway & Electric Company have taken over the interests of C. A. Hudson and J. C. Denny of Everett, Geo. D. Emery of Seattle and J. Kirkpatrick of Butte, and have begun work to harness the waters of the Sultan River at an estimated expenditure of $3,000,000. The plan is to build a concrete dam 120 feet high to conserve the waters, which engineers estimate will generate 50,000 hp. Further plan of the company is to construct a railroad from Sultan Canyon to the town of Sultan, 17 miles long. The power to be generated will be radiated to various cities on Puget Sound for industrial purposes.

FRESNO CAL.—The contract with the construction company in charge of the construction of the Fresno-Hanford Interurban Railroad has been rewritten to the complete satisfaction of the officials of the Hudson Counties Company of New York, according to an announcement by Sig Wormser, president of the local company, and it is believed by the directors that the rest of the bond subscription for the company will be shortly completed. The arrangements with the Hudson Counties Company provided for the subscription of $150,000 of the bonds by local capital, the Hudson Counties Company to then take over the remaining $850,000 of the stock. It is reported on good authority that $100,000 of the bonds have been taken in this section and that the rest of the subscription is assured. F. J. Haber, president of the Realty Association, who has this work in charge, declined to make any definite statement as to the amount taken up, but said that the outlook is promising. The canvassers are still at work. Mr. Wormser states that the newly written contract insures that the local board of directors will have complete power to protect all stockholders. He denied that all of the $150,000 worth have been subscribed.

WATERWORKS.

CATHLAMET, ORE.—The Council has decided to install a municipal water plant for Cathlamet. The estimated cost is $4,000.

HOOD RIVER, ORE.—Sealed proposals will be received by the Common Council up to 8 o'clock April 25th for the furnishing of material and labor for the construction of a complete municipal water system.

CLIFTON, ARIZ.—The Arizona Copper Company has applied to the Town Council for a franchise granting them the privilege of laying a new tailings pipe line through the residence section of Hills Addition.

SEATTLE, WASH.—The Council has passed an ordinance providing for the improvement of West Sixtieth street from Twenty-sixth avenue northwest to Thirty-second avenue northwest, by constructing water mains.

MOUNTAIN HOUSE, IDAHO.—The Council has passed an ordinance granting to the Commonwealth Power & Water Company a corporation of Spokane, Wash., a franchise for the furnishing of water for the city. The construction is to be commenced 60 days after the date of passing the ordinance.

RED BLUFF, CAL.—A notice has been filed appropriating 300,000 inches of water from the Sacramento River, about eight miles north of Red Bluff. As the location is near the Iron Canyon it is thought that the filing was in the interest of that project.

BERKELEY, CAL.—The City Council held a conference with Engineer H. Wilhelm and C. D. Maloney, representing the People's Water Company, recently, concerning the installation of an additional system of water mains in the city. The company proposes to expend $4 000 during the present year.

EAST LAS VEGAS, N. M.—The Agua Pura Water Company will make extensions in its system, and F. H. Pierce, manager, has engaged a consulting engineer from Boston, H. P. Eddy, and is prepared to inspect the water company's plant and make a recommendation. After inspection large mains will be installed.

SANTA ROSA, CAL.—An ordinance was passed by the Board of Supervisors, granting to L. Lewis, his heirs and assigns, the franchise, right, privilege and permission to lay, place, construct and maintain, under, through upon, over and across any or all of the county roads, highways, bridges, public ways, in the County of Sonoma, pipes, pipe lines and conduits with necessary service.

FRESNO, CAL.—A trust deed has been placed on record from the Coalinga Water and Electric Company of Fresno to the Southern Trust Company of Los Angeles to raise money to pay existing indebtedness acquire additional rights of way and secure plant and equipment, assigning $2,000,000 bonded indebtedness and mortgaging real and personal property in Fresno and Kings counties namely, machinery at the generating station, also the distributing system and the fractional block 10 of Coalinga, also franchises.

LONG BEACH, CAL.—The towns of Chinook and Long Beach are planning to unite in securing an adequate water supply for the two places. The source of the supply is Press Creek, about three miles from Chinook where, by constructing a dam across a canyon, a large reservoir can be formed at a sufficient elevation to provide a gravity system. To supply Long Beach will necessitate the construction of a main eight miles in length, and the railway company will be requested to grant permission for laying the pipe along its right of way.

SAN FRANCISCO, CAL.—R. G. Hanford, who, with William S. Tevis and a number of their following, has been engineering a plan to consolidate the People's and the Bay Cities water companies across the bay, has returned from another trip to New York, and is at the St. Francis Hotel. Mr. Hanford's return has caused a renewal of the talk of a water merger. Two previous attempts to reach the consolidation proved unsuccessful, and it was announced finally by Hanford and Tevis that they were through with the undertaking. It is said now that Tevis reconsidered his determination, having received assurances of certain concessions demanded by the promoters of the consolidation scheme.

OAKLAND CAL.—Mayor Mott believes that the cities served by the People's Water Company should band together and form a water district, under the provisions of the law established by the last State Legislature, and purchase the holdings of the corporation. Mott has proposed the matter to Mayor W. H. Noy of Alameda, who now has the project under serious consideration. The Mayor advocates the combining of the cities of Oakland, Berkeley, Alameda, San Leandro, San Pablo and Richmond, all of which are served by the People's Water Company, into one district for the purpose of purchasing the reservoirs, plants and system of the water corporation and placing it under municipal control.

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JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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VOLUME XXIV SAN FRANCISCO, APRIL 23, 1910. NUMBER 17

"The Marysville Buttes."

THE NORTHERN ELECTRIC RAILWAY

By Rudolph W. Van Norden
Member A. I. E. E., A. S. C. E.

After two or three days of travelling 'mid the everchanging landscapes of desert and mountain, the tourist on an overland train,—or possibly he may be a settler, looking for new fields to till in a land full of promise—looks out over the wide expanse of the great central valley of California with a sense of relief. His train is reeling off the last few miles before entering Sacramento, the Capital City.

As his gaze rests upon the seemingly limitless expanse of almost level country, he will, perhaps, ask somebody (and if it be a Californian he cannot resist telling of the beauties and possibilities of his country), what is it good for; can it be cultivated; what will it raise and a hundred other questions. Probably he will ask why all this land has not been settled on and cultivated long ago. The answer will be that it has, in spots, but that it is too big and there have not been enough people, or the facilities for transportation, to do it all at once.

If he is wise, he will stop over at Sacramento to seek further knowledge. Is this great country being built up, are the Californians doing it, or must I and those who follow me supply the necessary energy to start this great work? To the first query he is answered, Yes; to the second, he is told to look for himself, the way has been paved.

He is handed a time-table and his eye is attracted to the reminder below a copious list of trains, "a. stands for A. M., p. stands for P. M., and Northern Electric stands for development of the Sacramento valley." Now he knows the whole story and when he boards the spic and span electric train, whose very color breathes California romance in its reflection of the Golden Poppy, whose blossoms cover like a mantle the fields through which he is destined to pass, to be whisked by miles of fertile lands and to pass through towns where prosperity is evinced on every hand, he marvels at the work already done, the enormous possibilities for the future and then he feels like making a profound obeisance to the train, when he leaves it, for its share in making this development possible.

Description of the Country.

The Sacramento Valley has a length of about 200 miles and a width averaging 50 miles. The Sacramento river passes through its entire length from north to south and divides it about equally. The land adjoining the river on both sides is, as a rule, low and fairly flat and as it recedes from the river gradually rises and becomes more undulating until the foothills of the Sierra Nevada on the east and the more precipitous mountains of the Coast Range on the west are reached.

The one exception to this general condition is furnished by the "Marysville Buttes," a jagged group of volcanic peaks which appear to have been forced out of the depths of the earth in defiance with nature's plan of arrangement, into the very centre of the valley. These buttes can be seen from all points of the valley and are a picturesque contrast with the level expanse surrounding them.

The land throughout the valley has always been known to be fertile, but the bottom lands along the river are particularly so. Many sections on both the west and east sides have been under a high state of cultivation for years, but the bottom lands, due partly to the cost of reclamation works to prevent the overflow from the Sacramento river and also the lack of railroad facilities, have not had the opportunity for development that their value would seem to assure.

That the country with its relatively meagre population has much wealth is shown by the prosperous cities and towns scattered throughout the valley, the numerous and well equipped banks and the carefully appointed stores and business houses.

The cultivation of hops, wheat, sugar-beets, oranges, olives, the deciduous fruits and many other crops, of the finest quality and greatest quantity, wherever undertaken, aside from the possibilities for the recovery of gold in the rivers, pointed a reason for a rapid growth in population and wealth that might be expected with the advent of rapid and convenient transportation.

The great necessity was transportation. It was not expected that this would turn miles of uncultivated or overflowed land into a highly productive garden in a moment. But it was the late Mr. Henry Butters who believed in the country and the people and saw that the establishment of a modern railroad, affording swift means of transportation between the towns and through country having high potential values, would be the means of inducing a rapid but healthy growth and be the nucleus of a great system surrounded and fed by a great country.

It is no easy matter to inaugurate a new railroad through a more or less undeveloped territory. The financial start is often a hard thankless problem and the work which Mr. Butters and his associates had undertaken represented the faith and courage, characteristic of all the great enterprises in this, a comparatively new country.

The start was made at Chico and under the engineering direction of Mr. J. B. Robinson, a veteran railroad engineer, and Mr. J. Paulding Edwards, the electrical and mechanical engineer, to whose skill and ingenuity the system now owes its well designed and successfully operating equipment, a road 24.8 miles long was built to Oroville. These cities were growing and prosperous, the former in the midst of a fertile and well cultivated district, with growing industries of great promise, the terminus of a lumber railroad, a number of stage lines and the distributing point for a large mountain territory; the latter city, being in the foothills, likewise a stage line terminal and distributing point and the center of one of the greatest gold producing localities in the world.

There was no direct means of transportation between these cities, except by stage and the first section of this system seemed justified by these conditions.

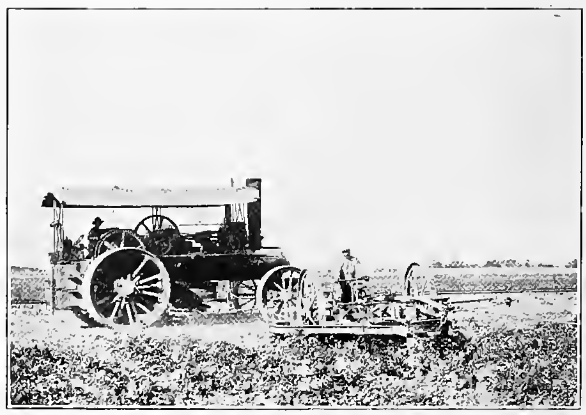
The first car from Chico to Oroville was run through on April 25, 1906. The success of this piece of railroad was an inspiration to spur on the work of further construction and on December 2, 1906, the line was completed to Marysville, an additional distance of 30 miles and regular operation was commenced.

There was in Marysville a primitive street railway system, its diminutive cars being hauled by mules. This was purchased, the road relaid with heavy rails and made standard gauge and extensions made to give a first-class local service throughout the city and between it and Yuba City, across the Feather river.

A local system was also purchased in Chico and in Oroville, a loop was built and a local service between that town and Thermolito was inaugurated. Thus these towns not only were provided with a means of rapid and frequent inter-communication, but were enabled to enjoy the benefits of urban transportation.

During 1907 construction was continued between Marysville and Sacramento and on September 1st of this year regular service was commenced.

Sacramento while literally not the head of navigation is practically so. There are several lines of steamers which tie up at this point; the possibility of making the road an outlet for a large freight transportation business, having steamer connection with the Bay Cities was apparent. Aside from a passenger terminal in the heart of the business section a branch to a freight terminal on the water front was built. This then gave a clear line of railroad reaching 122 miles up the Sacramento valley.

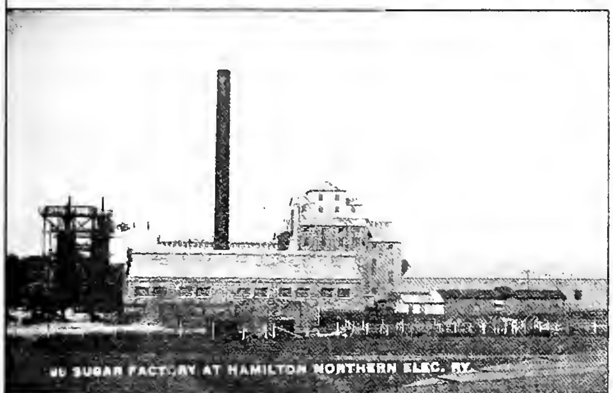


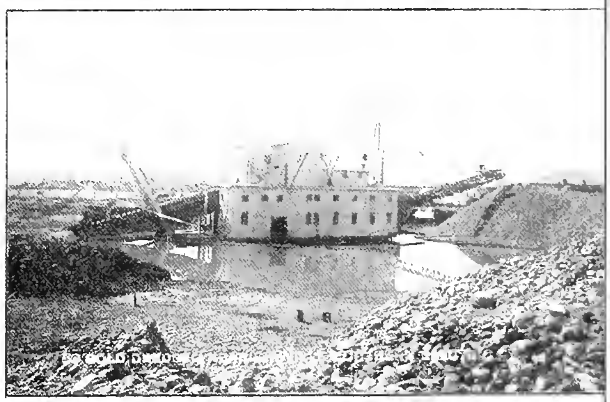
Plowing Sugar Beets Near Hamilton by Steam Power.

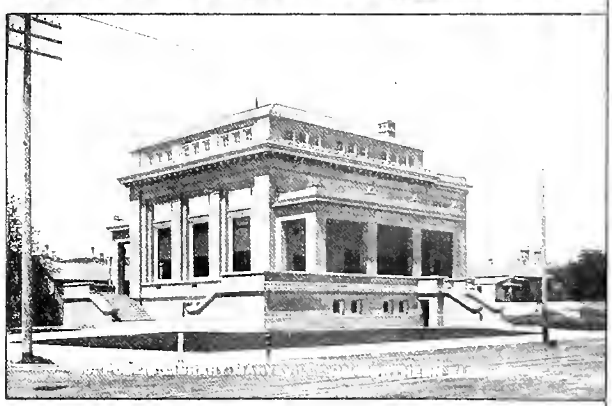
On the west of Chico and adjacent to the Sacramento river is a large section devoted to the cultivation of sugar-beets. There is at Hamilton a sugar factory. A line was therefore built from Chico, due west to the Sacramento river and after crossing the river, following the west side to Hamilton, a distance of 11 miles.

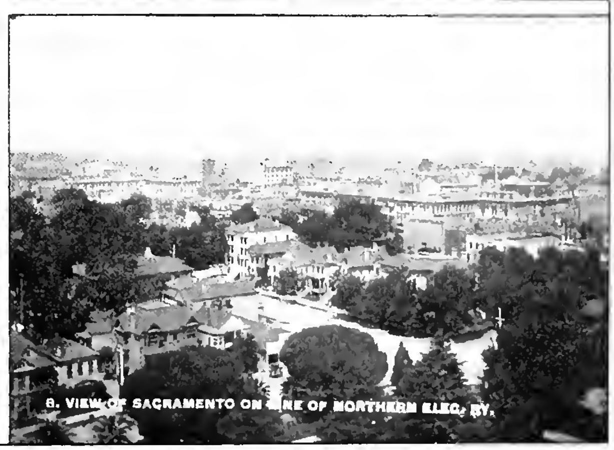
It is now proposed to continue the main line north from Chico, and following up the valley for 41.7 miles, to the city of Red Bluff. Surveys for this work have been made and much has been done toward the completion of this extension.

Another extension is in process of construction. This leaves the main line 4.4 miles north of Marysville and will extend due west to Meridian and after crossing the river, proceed northward to Colusa, a town on the Sacramento river. This branch will be 22 miles long and traverses a wonderfully fertile, but more or less undeveloped country. The land adjacent to this new line is mostly of sufficient height above the level of the overflow from the rivers to enable cultivation without the necessity of drainage. The soil here is from 18 to 25 feet in depth and has been pronounced









Views Along the Lines of the Northern Electric Railway.

On Main Line Between Marysville and Chico.

by the soil expert of the U. S. Government to be the premier of all California lands.

The absolute lack of transportation facilities is the only thing that prevented development here and illustrates one of the great possibilities for business of this system.

When that section between Marysville and Sacramento was commenced, the conditions were much the same; thousands of acres of the richest land were lying idle; today there are a half dozen towns laid out. Where three years ago there was not a person to be found for miles at a stretch, there are today scores of farms springing up and a rapidly increasing population. And the well filled, frequent trains are a tribute to the wisdom and sagacity of the founders.

General Description of Main Lines.

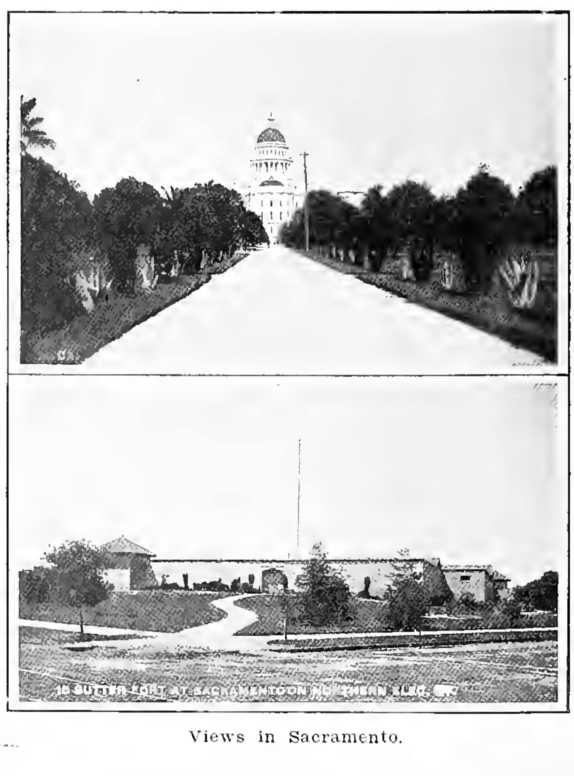
The Northern Electric has a total of 122 miles, not counting the local street railway systems which have a total of 17 miles of track; when the extensions, now under construction are complete, this will be increased to 193.5 miles.

The road between the present terminals, Chico on the north and Sacramento on the south, lies practically north and south in a generally straight line. That section of the road into Oroville is treated as a branch; it joins the through line at Tres Vias and runs east for a distance of 5.5 miles to Oroville. Except for that section where the foothills are approached nearing Tres Vias and the Oroville branch, the road is essentially level; the maximum grades at the points mentioned do not exceed 1 per cent.

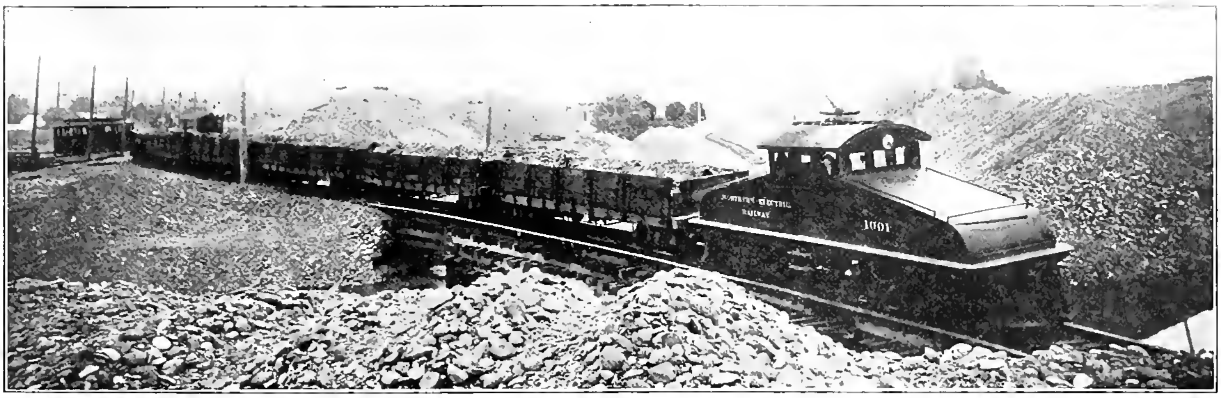
The rail equipment throughout is of 60 lb., A. S. C. E. standard profile.

Sawn cross ties from the hearts of pine and fir timber were laid throughout the system, this timber being of good quality and supplied by the Diamond Match Company from their forests in the nearby Sierra Nevada mountains.

Throughout the system a high class of track construction is in evidence; the nature and height of embankment show a careful study of conditions. Except for about ten miles on the Sacramento end, the track is thoroughly stone-ballasted. Rock for this purpose has, for the most part, been hauled from the tailing pits of the gold dredgers at Oroville. A crush-



Views in Sacramento.



Hauling Rock for Ballast from Dredger Pits at Oroville.

ing plant at this point consisting of a No. 5 Gates crusher, electrically driven, with the necessary equipment, was provided for this purpose. This rock is all in the form of boulders and cobbles and much of it very hard. There is, of course, a large percentage that does not require crushing.

From Chico to Yuba City the road passes through a number of towns—Durham, Live Oak, Gridley, Biggs and several prospective colonies which are rapidly becoming populated. There are few curves and those are of long radius, while there are long tangents, the longest being fifteen miles.

Particular attention has been given to the design and construction of culverts, cattle-guards and fences. The first, while of little use during a large part of the year, become very important factors during the rainy season, disposing of the sometimes rapid run-off gathered from the broad flat lands adjacent to the road.

The country is being cut up into small farms and holdings which are becoming more numerous every year. These necessitate many crossings, some public, some private, and therefore the greatest care must be exercised to prevent animals being driven or wandering over these crossings from getting on to the right of way and coming in contact with the third rail. A number of standard designs have been adopted for installation where the height of embankment varies.

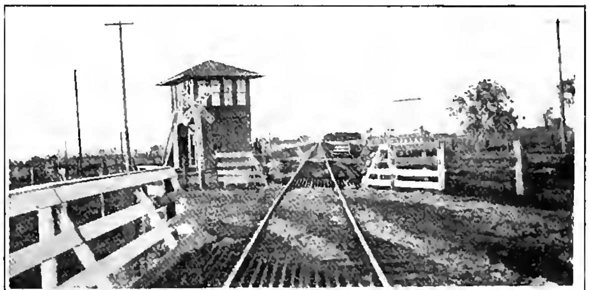
It is, of course, necessary to have fences on either side of the right of way, which are not only sufficient to keep out cattle and other domestic animals, but even dogs and rabbits.

The right of way is from 80 ft. to 100 ft. in width.

Being a single track system, it is necessary to pay great attention to meeting points in the running of trains. There are sidings at all the principal stations, but additional sidings at the proper points have been provided for this purpose. At these sidings there is a box mounted on a post; this contains a telephone connected to the private wires of this road. A train conductor can, by this means, get into communication with the Dispatcher and may readily ascertain the position of any and all trains he has orders to meet.

At Live Oak the road crosses the line of the Southern Pacific at grade. There has been placed here an interlocking switch tower at which an attendant is constantly on duty. This tower was built and is maintained jointly by both railroads.

From Yuba City the road crosses the Feather River on a steel truss bridge into the city of Marysville. This bridge is owned jointly by the railroad and the counties of Yuba and Sutter, and supports a roadway, as well as the track. A very difficult and interesting problem was encountered during its construction. It

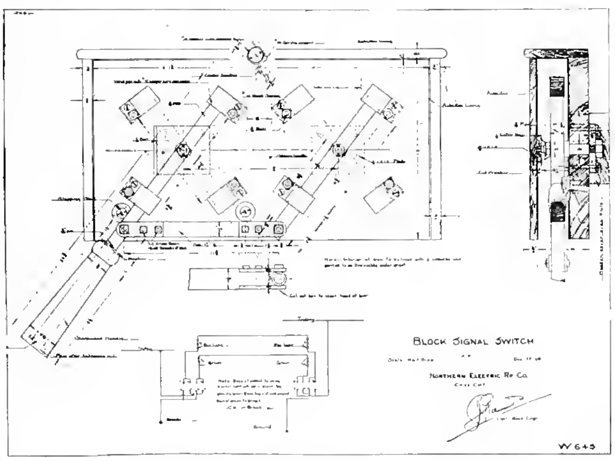


1. Interlocking Tower at Live Oak.
2. Approach Into Marysville Between Wing Levees.
3. Subway Through Levee at Sacramento.

was built to replace an old wooden structure and while the work was in progress, both the railroad and the wagon road were at all times in use.

Steel Bridge Over the Feather River at Marysville.

There is a single track over this bridge and so, to prevent the possibility of an interurban train and a local street car from meeting on the bridge, a simple block system has been installed. It consists of a box at the commencement of the embankments at either end of the bridge, in which is a switch. The throwing of these switches cause a danger signal to show at the opposite end from the switch thrown. A diagram of this switch is herewith reproduced.



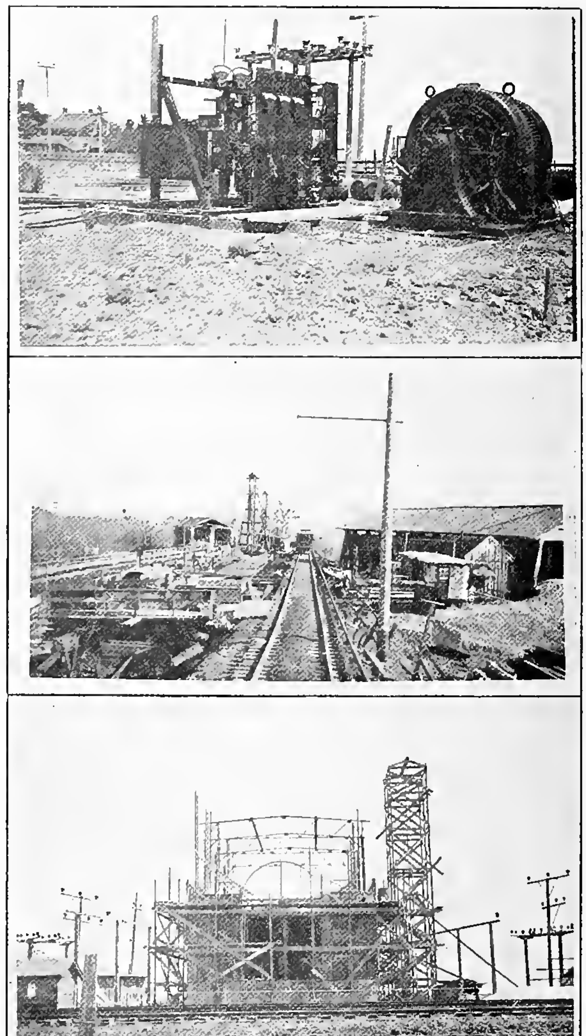
Marysville lies between the Feather and the Yuba rivers, the latter joining the former at this point, forming a right angle. The city is at times below the water level of the rivers, and is thus surrounded by levees. In order to give a proper grade from the bridge to the streets of the city, it was necessary to cut the levee. This was accomplished by building wing-levees and the resulting roadway has been made into a sort of boulevard.

After passing through the principal streets of Marysville the road turns south and crosses the Yuba River, this time on a timber pile trestle. The United States Government is at present undertaking the work of altering the course of the Yuba River so that it will eventually join the Feather River at a point south of the present junction. In anticipation of this change the trestle was not constructed as a permanent structure, but at the point where the track will cross the new channel there have been placed nineteen 40-ft. steel spans supported on permanent concrete piers.

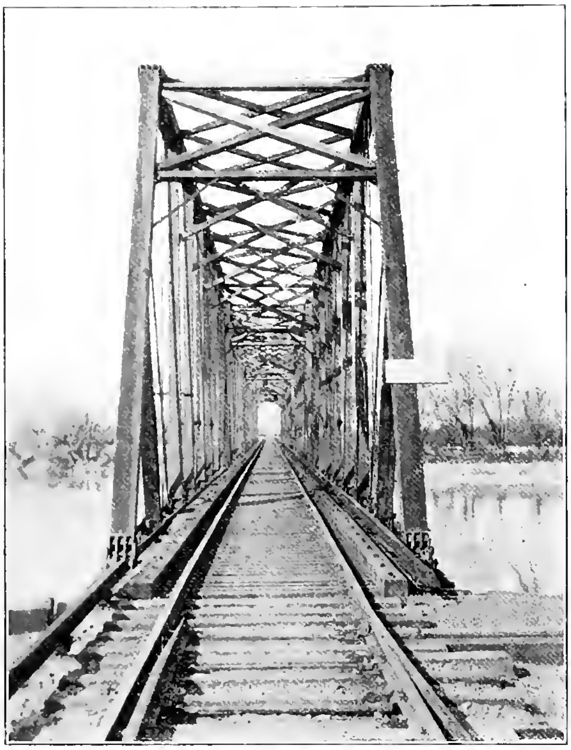
Following the crossing of the Yuba River the road enters a low flat country which, while not actually subject to overflow from the Sacramento River, has as yet not been thoroughly diked, and is subject to overflow, during periods of very high water, from the Yuba and Bear rivers. This fact and the sometimes quite heavy current of the overflow necessitated a class of roadbed construction which would at once resist any current pressure to which it might be subject and at the same time turn the currents into proper channels through culverts and other openings. This has been accomplished by first building substantial pile trestle and then filling it out with an embankment consisting of the tailing cobbles and gravel from the dredger mines at Oroville. This material will remain in place under the most adverse conditions of flood and current.

Dikes and levees are now nuder construction for the reclamation of this district.

The last thirty miles of the road before reaching Sacramento is in a flat but well-drained country, and is not subject to the possibility of overflow. There are throughout this section a number of well laid-out town-sites and from the frequent sales of real estate,



1. Temporary Sub-Station.
2. Replacing Wooden Bridge Across the Feather River at Marysville with a Steel Bridge.
3. Sub-Station No. 8 at Nicolaus under Construction.



Bridge Over the American River Near Sacramento.

in small holdings, give every evidence of a very rapidly growing population.

The road enters Sacramento after crossing the American River. This it does on a composite Howe truss bridge. In entering Sacramento very much the same condition is encountered as that at Marysville. It is necessary to go through a levee. Wing-levees are built to allow of this entrance. At the lowest point of the cut, at the center of the levee, it has been found that water would seep through from the river and collect in the cut. Provision to obviate this has been made by installing a small motor-operated pumping rig. The cut is heavily constructed with concrete piers and wing walls and supports several railroad tracks, laid lengthwise of the levee.

Within the city the road has a double track and passes through a number of streets until the passenger terminal at Eighth and J streets is reached. There is a "Y" provided here to enable the turning around of cars or trains.

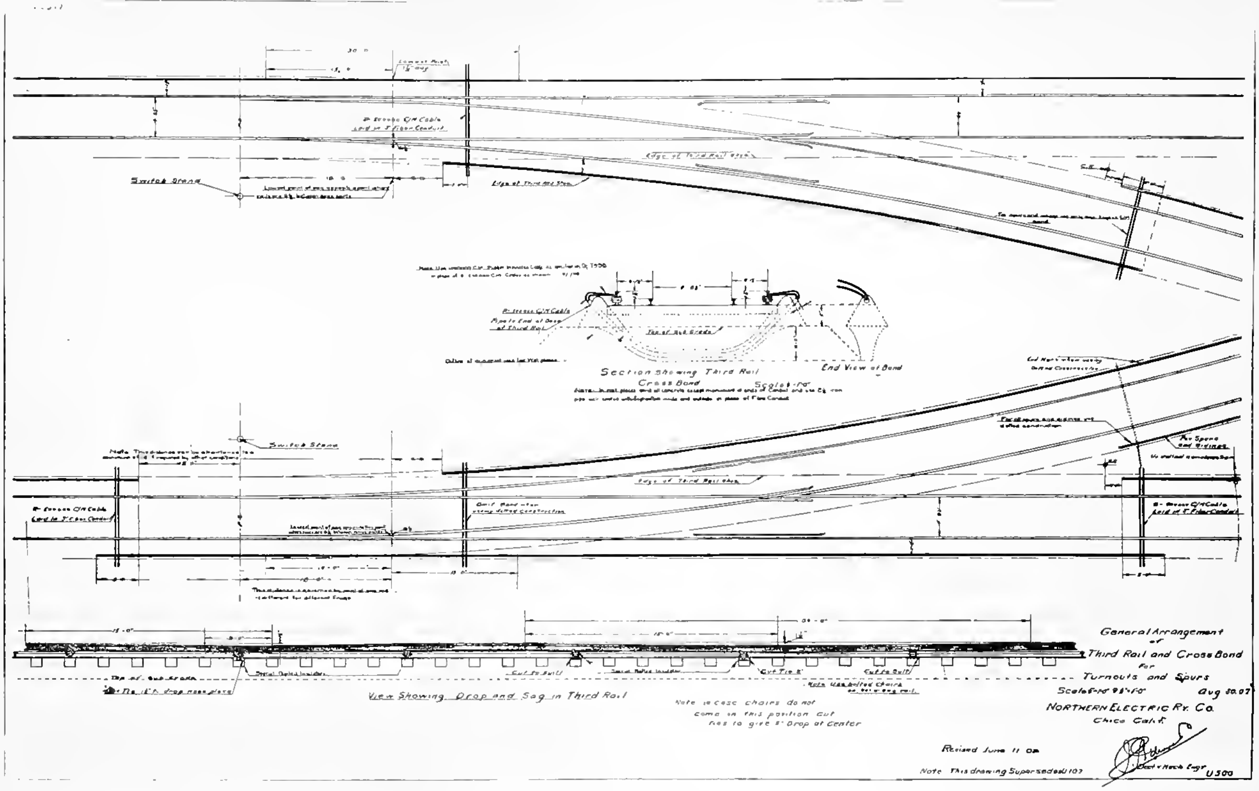
Soon after entering the city, a branch line has been constructed to a freight terminal at the city wharf on the Sacramento River. This line practically circles the city, as it was not possible to secure a franchise to operate freight trains through the streets. This branch is 5.7 miles long and its construction throughout is equal in quality to the high standard maintained by the system.

Freight Depot at Sacramento.

The freight depot is a commodious structure, of sufficient size to handle the cars and business for some time to come; it takes up a large part of a block east of the wharves. The tracks are so arranged that cars may be shunted directly on the wharf and loaded to or from the steamer.

The question of the method of supplying electricity to operate trains was one which received a great deal of thought and consideration. For long distance interurban work, both the various forms of trolley construction and the third rail have their advocates. The engineers in charge of this work were strongly in favor of the latter course and it was adopted. The subsequent result seems to point to their wisdom.

The Wharf at Sacramento; Steamer "Pride of the River" on Right.



Standard Switch Details.

Through cities and towns a plain trolley construction is used; the cars are therefore equipped both with the trolley and the third-rail shoe. In changing from the former to the latter and vice-versa, the trolley is raised and lowered in the ordinary manner. An ingenious device, controlled by interlocking automatic relays, cuts out electrical connection to the shoe when the trolley is in use. This is described elsewhere, together with the car control system.

Standard forms are used for switches and crossovers, passing tracks, etc.; this is important, as the position of the various arrangements for the third-rail must be accurate.

An ingenious but very simple device is used on switches to electrically disconnect the third rail when the switch is not in use. It consists of a break in the rail, in which is inserted an insulating wood block. Fastened to the rail at either end of the break and extending sideways in a horizontal direction are two hook-shaped receptacles. An iron rod, with a wood handle at one end, which acts as an insulator, is laid on these projections in such a way that it fits into the curve or hook of each. This closes the circuit. When the track is not in use, the bar is simply pulled out.

Third Rail Disconnecting Switch.

The third, or electric rail, is 60-lb. steel, having the A. S. C. E. standard profile. It is mounted on a special insulator, designed by the engineer of the road. This consists of a treated maple block, fitted to a malleable cast-iron base and supporting a cast-iron flaring top, to which the rail is fastened. The insulators are placed on every fifth tie, which is 18 inches longer than the others, for this purpose.

The loss by current leakage from the third rail is remarkably small, being one-half ampere per mile, under the most severe conditions of weather.

The track rails are bonded with two No. 0000 and the electric rail with two 400,000 cir. mil. Chase-Shawmut soldered bonds.

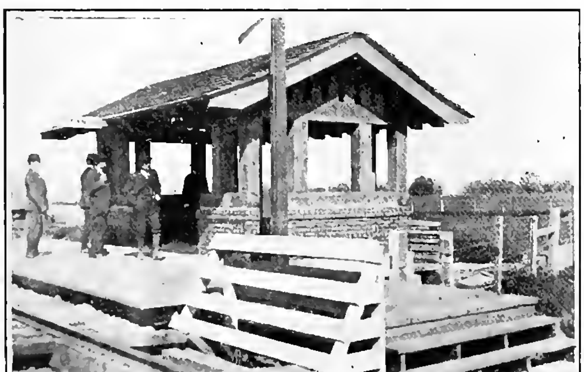
At road crossings, where there would naturally be an interruption in the electric rail, a heavily insulated cable was laid beneath the crossing; this was found to give trouble and resulted in changing a number of these underground cables to an overhead construction, two poles being used for the purpose. This conductor is made of two 500,000 cir. mil. copper cables.

Stations.

A number of types of passenger stations have been adopted. A new depot at Thermolito built largely out of cobbles is of a very neat and artistic design. The illustrations give a good idea of this progressive type of building.

Method of Carrying Third Rail Conductor Over a County Road.

There are a number of points along the road which, while an attendant is unnecessary, afford considerable passenger business. These are simply shelter stations and are constructed on a standard design. They are equipped with a manually operated semaphore, which when in a horizontal position, lights a series of 5 lamps for night use. The cost with a 100 ft. platform is about $450.

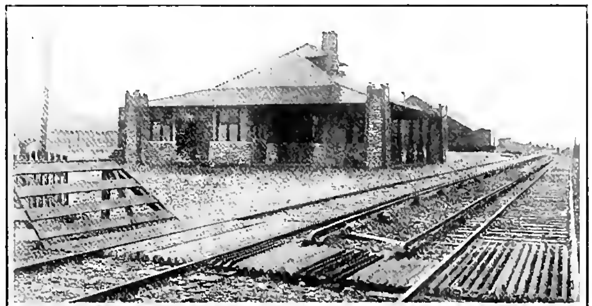


1. Shelter Station. 2. Station at Tres Vias.

Car-Houses, Repair Departments, Etc.

Located at Mulberry, a suburb of Chico, are the main car-houses, the repair-shop, the car-building shop and the administration offices. Here is also a sub-station and the office of the Chief Train Dispatcher.

The car-houses are conveniently placed, facing the county road, on which the main line operates. The building is a concrete and timber structure, 140 ft. by 140 ft., covered with corrugated iron, and contains eight tracks, all of which connect with the main line. Within the building there are pits throughout the length of the two tracks adjacent to the machine shop,



Depot at Thermolito and Its Artistic Interior.

so that temporary or permanent repairs may be made at any time to the working parts of coaches or locomotives. Doors at the rear of four of the tracks allow the passage of cars through to the car-shop, which is located directly in the rear of and a short distance from the car-barn.

On the right, as one enters, incorporated as part of the car-house building, is the sub-station, described elsewhere. Behind this is a machine shop, equipped with all the machines necessary for car-repair work. Next to these shops is the air-brake department, with equipment for repairing and testing of this apparatus. In the rear and adjacent to these shops is a forge-shop. This has six forges and one 300-lb. hammer.

To the left and at the rear of the car-house is the armature and electric repair department. Armature repairing is perhaps the most important of the various classes of repair work on an electric railway system. The repairing and rewinding of railway armatures has become almost an exact science and the work is thoroughly and expeditiously handled here. A little device, designed in this shop, for slotting commutators

is of interest. After the commutator has been turned and finished, this slotting device, consisting of a steel circular saw, mounted on a mandrel and driven by a motor, is run between each commutator bar. The armature is mounted in such a manner that its axis is perpendicular to that of the mandrel and is turned automatically, after each slotting operation. This act of slotting removes the "burr" and a small portion of the insulation at the edge of the commutator bar, leaving the bar clean cut and every slot the same width; it increases the life of the commutator and the brushes and prevents "flashing over."

Passing from the car-house to the car-shop, one finds a well-constructed corrugated iron building, equipped for the erecting and finishing of cars. A wood-shop with machinery to turn out all the work from the heavy frames to the inlaid hard-wood finish is at one end; at the other is the paint shop.

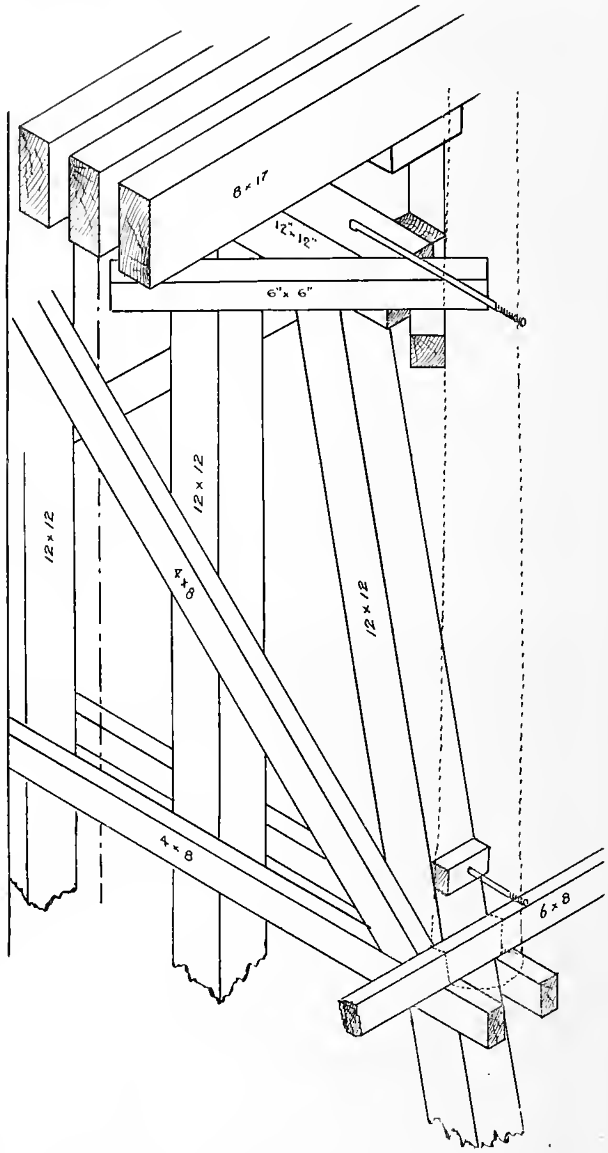
Many of the later cars of this company have been built in this shop and a minute examination evinces the care and thoroughness exhibited in their construction and a finish which it would be impossible to get on cars purchased in the open market.

One of the latest examples of the product of this shop is car No. 130. This is a combination passenger and baggage type; it has a length of 50 ft. over all and the weight equipped is 83,400 lbs. The interior finish is Honduras mahogany, the panelling being inlaid with white holly and ebony in a neat marquetry design. The ceiling finish is full "Empire." The seats were furnished by Hale & Kilburn and are covered with a figured blue plush. There are toilet facilities at both ends and in general the car is the embodiment of the most modern design for comfort and ease.

The motor equipment consists of four 90-h.p. Westinghouse No. 121-A motors mounted on Baldwin No. 200 single trucks with 36 in. standard rolled steel wheels.

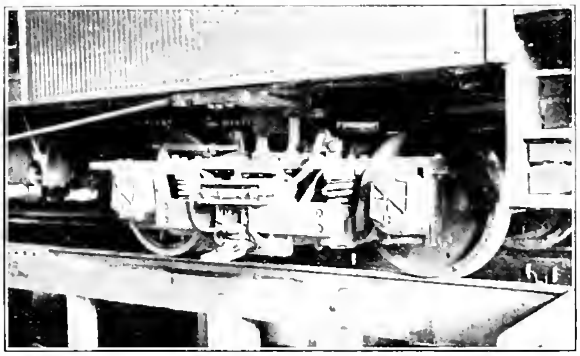
The air-brake system is Westinghouse automatic, schedule AMM, with quick release and recharging feature. Air is supplied for the air-brake system by a Westinghouse D-3 air-compressor set, slung from underneath the car-body in the usual manner. The draft-gear is of the "radial" type, described elsewhere, and the control is by the electro-pneumatic system, which has been adopted on all of the cars of this company.

The third-rail shoe, or current collector, is of cast-steel; it has a hinged mounting and is fastened to the



Standard Connection Between Pole and Trestle Bent.

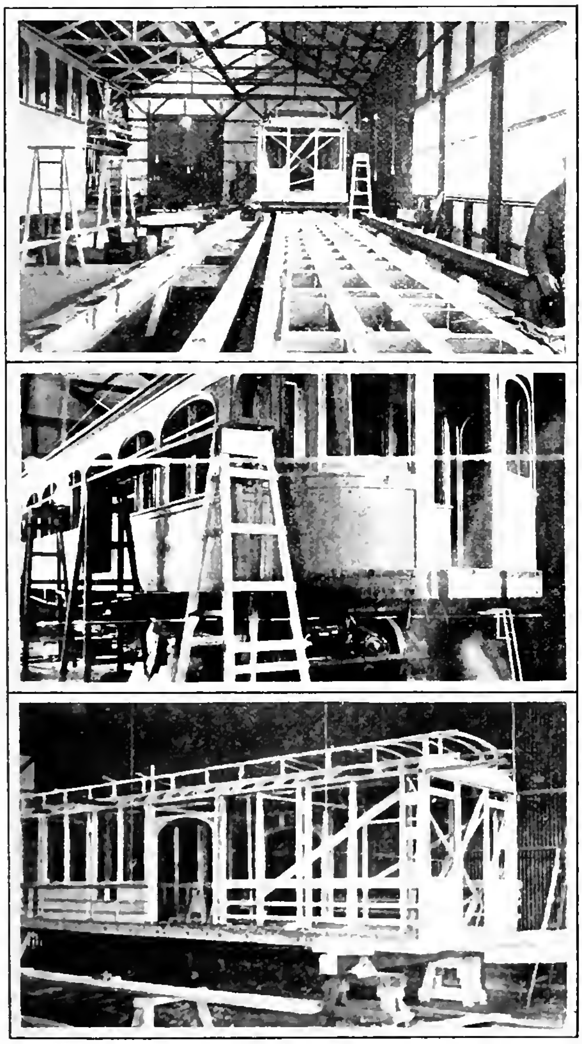

The Car-Houses at Mulberry.



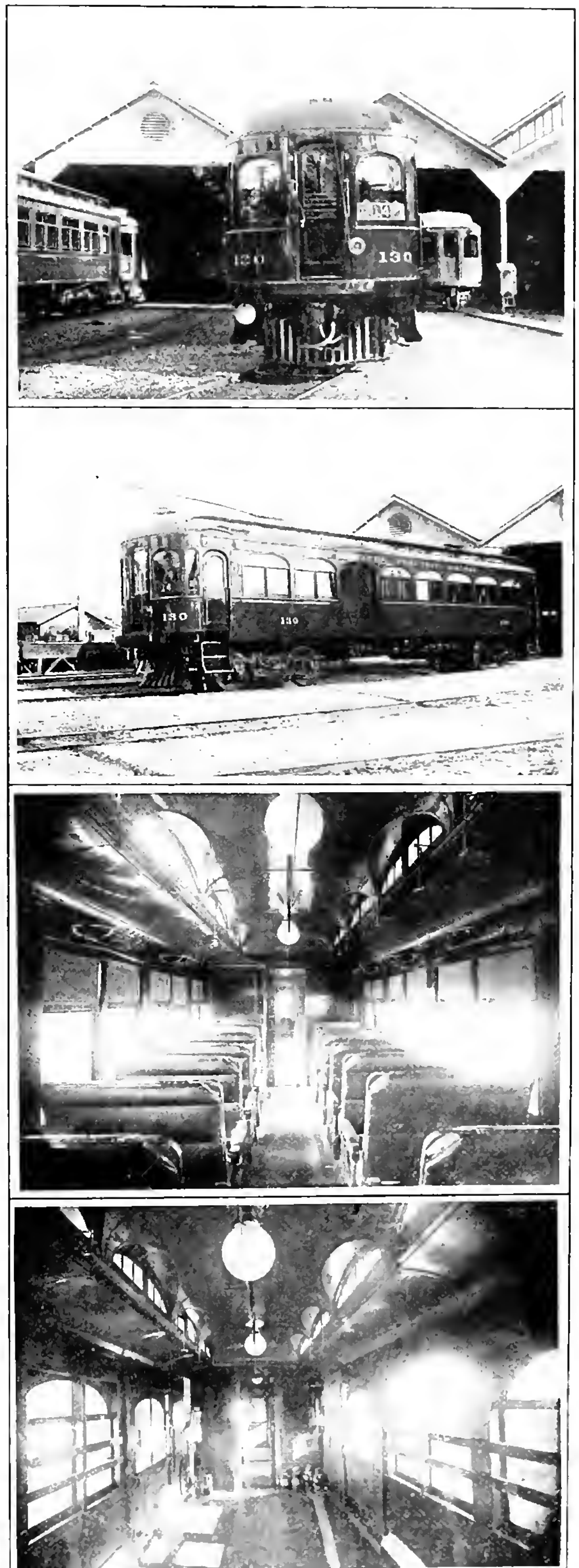
Third Rail Shoe in Use by the Northern Electric Railway.

truck in a simple and effective manner. This arrangement is another of the many features designed for this system by its engineering department.

A fuse is carried above the shoe, where it is readily accessible. This fuse is made from sheet copper and is a strip of the proper width to be effective; at its middle point a hole is drilled. When the fuse is ruptured it naturally breaks through the hole as the



Views Showing Various Stages of Coach Construction at the Mulberry Shops.

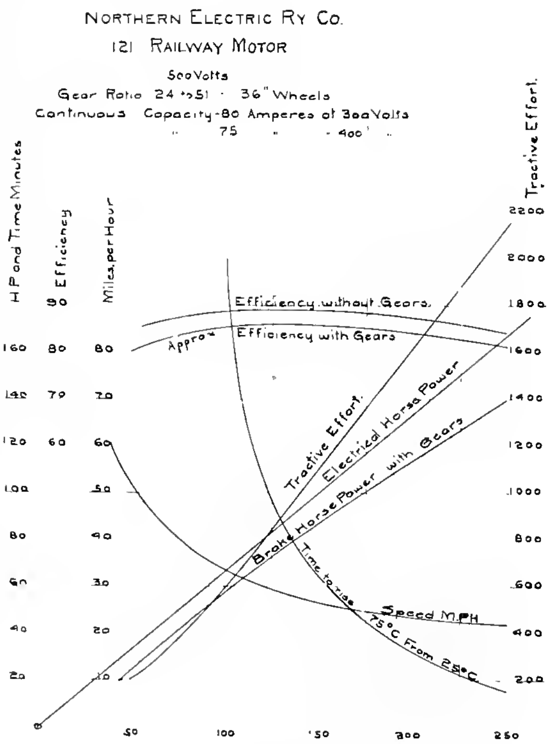


Exterior and Interior Views of the Car No. 130.

greatest current density is at that point. The inductive effect caused by the breaking of the fuse has a tendency to separate the broken ends, thus preventing the arcing over of the current.

LIST OF ROLLING STOCK AND EQUIPMENT

Type of Car.	No.	Weight.	Length.	Motor Equipment.	Trucks.	Brakes.	Shop.	Gear.
Combination (baggage, smoker, pas.)	2	85,860	56 ft.	Quad. West. 121	Bald. 200 36″ wheels	West. aut.	Reb.	24/51
" "	3	80,000	"	"	"	"	"	"
" (passenger and baggage)	6	83,400	"	"	"	"	Built	"
" (mail and baggage)	3	40,000	55 ft.	....	St. Louis 34″ wheel	"	Reb.	.....
Passenger coaches	3	55,000	52 ft.	....	"	"	.....	.....
" "	3	78,400	56 ft.	"	Bald. 200	"	.....	"
" "	1	76,000	52 ft.	"	"	"	.....	"
" trailers	10	61,250	56 ft.	....	....	"	.....	.....
Combination (open and closed)	2	49,500	39 ft.	Quad. West 93-A	"	West St.	.....	22/65
" "	3	36,000	39 ft.	Doub. GE-202	St. Louis	"	.....	15/71
Open 14-bench cars	2	30,000	40 ft.	Doub. GE-67	"	Hand	.....	19/65
Single truck, city cars	4	17,000	28 ft.	Doub. GE-800	Brill, 21E	"	.....	14/67
Locomotive (steel)	1	64,600	31 ft.	Quad. West. 121	Bald. 200	West. St. & aut.	Built	16/59
" (Cons. type)	3	79,500	40 ft.	"	"	"	"	"
" "	1	37,600	36 ft.	Quad. GE-67	St. Louis 47	"	"	16/65
" (steam)	3	120,000gr.	.....	16 x 24 cyl.		West.		
Flat cars	161	27,000	40 ft.	40 tons cap.				
Rodgers ballast cars	50	36,500	37 ft.	"				
Box cars	99	37,200	38 ft.	"				
"	36	22,800	28 ft.	20 tons cap.				
Flat cars	1	22,800	37 ft.	"				
"	22	16,300	31 ft.	15 tons cap.				
Wrecking car	1	......	.....	2 15-ton cranes.				
Line tower car	1							
Water car	1							
Steam pile driver	1	......	.....	30-h.p. engines, 3600-lb. hammer.				
Rodgers ballast plow	1							



Characteristic Curves of No. 121 Railway Motor.

Lighting is accomplished by five enclosed arc-lamps in the ceiling and there is also an arc headlight.

A maximum maintained speed of 52 miles per hour is possible and is about that to which all of the interurban cars are geared.

The freight locomotives are a development of this company; that is, each one has been built with the special conditions of operation in view and some novel features have been incorporated.

The first one put in use was a combination of the various parts which could be quickly procured. It was an ordinary flat-car, four second-hand street-railway motors, a controller from another source, and some lumber to build a cab. This primitive freighter has had a good record for work and is even now in use for switching purposes.

Designs for passenger coaches and freight locomotives, having steel framework and covering, have been made; none of the former have as yet been constructed, but one of the latter has been built and is proving itself to be highly satisfactory.

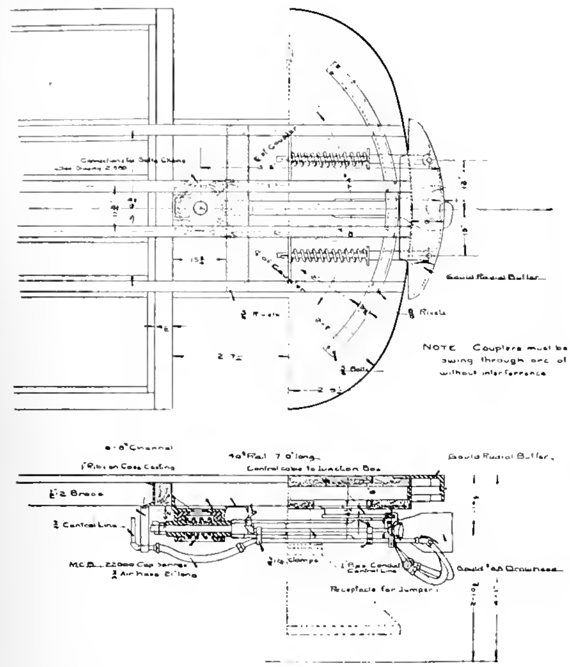
COST OF CAR NO. 130.

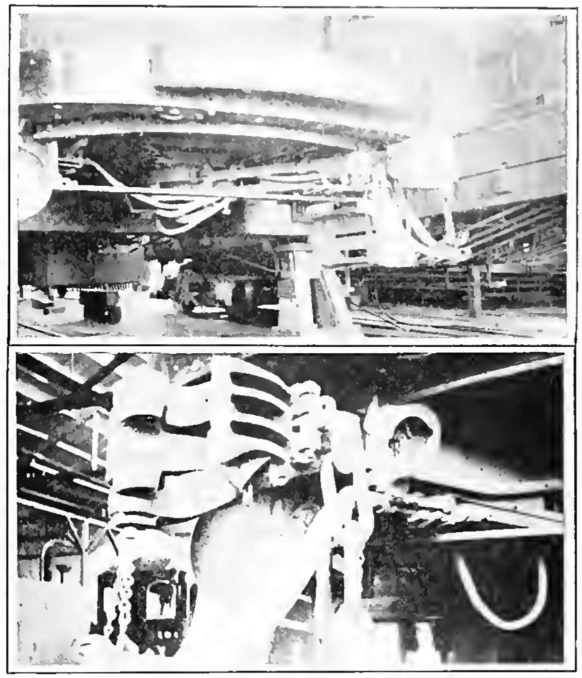
Class of Work.	Labor.	Material.
Body	$ 817.25	$1,126.04
Complete body	2,269.91	1,304.94
Paint	424.72	122.53
Electrical equipment	369.27	1,871.58
A. B. equipment	152.92	690.03
Radial draft gear	61.84	10.57
	$4,095.91	$5,125.69

Total shown	$ 9,221.60
Trucks not included	1,486.00
Motors not charged out	2,848.00
Cost complete	$13,555.60

The freight locomotives have the same motor equipment as the passenger cars, but are geared to a speed of 25 miles per hour.

There is a device installed, operating in conjunction with the multiple-control which consists of a switch that throws all four motors in series; this is for starting heavy loads. When the train is once started, this switch may be thrown back again, thus restoring the regular connections between the controller and the motors.





Views of Radial Draft-Gear.

The Westinghouse Electro-Pneumatic System of Car Control.

It has been already stated that this system has been adopted for the control of all interurban cars and trains. While it is a standard system, its working is not universally understood and a description in detail will be of interest to many.

At the request of the writer, this system as used by the Northern Electric Company is described by Mr. Edwards as follows:

General Description.

The system is designed for the operation of motor coaches for train service, consisting of a solid train of motor coaches, or a train of motor coaches with intermediate trailers, or for the operation of motor coaches, as single units. The motors throughout the train are operated simultaneously, each taking a proportionate share of the load and the control of these is affected at a single point at the head of the train.

The system is electro-pneumatic and utilizes compressed air from the air-brake system for the operation of the main switches in the motor circuit. Electro-pneumatic valves govern the admission of air to the operating devices; the operating coils being in a separate low-voltage circuit entirely independent from the motor circuit. This low-voltage circuit is the only one which it is necessary to establish from car to car, and is also the only one brought above the floor of the car. There are thus two circuits electrically independent, viz:

(1) The operating circuit, carried throughout the train and energized by a small storage battery.

(2) The motor circuit, confined entirely to each motor car, including the motors and switches for connecting these in series, and parallel, with the various resistance steps.

The apparatus for handling all main currents is located beneath the body of the car.

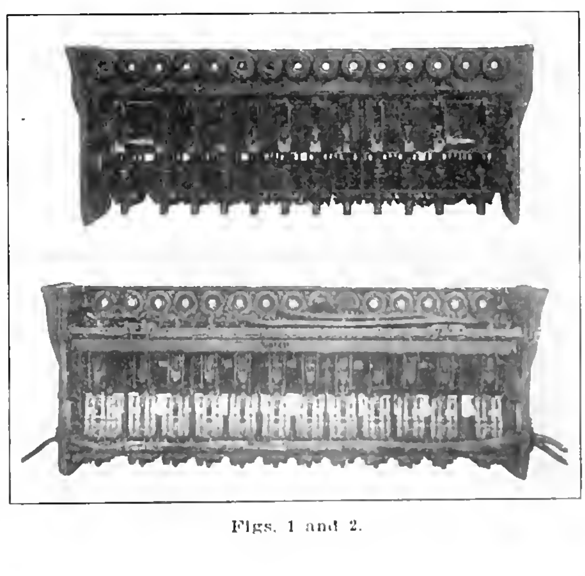
The Switch Group.

Fig. 1 is a front view of the switch group with the covers removed, showing clearly the contacts and arc chutes, and electro-pneumatic valves.

Fig. 2 is a rear view showing interlock fingers and contacts.

These switch groups consist of twelve independent unit switches grouped together in a line and mounted on a frame forming a small capacity air reservoir. Between the switches are arranged blow-out coils. These blow-out coils are either connected together in series in the main circuit, or in single switch circuits, as may be the case; dependent on the various switch movements.

The switches and blow-out coils are surrounded by incombustible vulcabeston boxes, the switch box being lined with asbestos and soapstone arc shields. The switch arm is hinged upon a support and carries



Figs. 1 and 2.

a contact proper, which has an independent movement affected by a spring acting between contact and arm. The operation of this spring secures the initial contact at the point of removable contact tips, and the final or resting position further along the surface, giving a wiping and rocking motion of the fingers, maintaining a positive contact upon which deterioration is a minimum. The piston of each cylinder is connected through an insulated joint to the switch arm. On the piston rod there is an arm holding an interlock segment, securing simultaneous movement of interlock and piston. The air cylinders are bolted to the cylinder head, which also forms a shell for valve magnet, this casting having a channel connected with the air chamber to which it is bolted. The switches are bolted to a substantial base plate bolted to the air chamber frame, the switch bolts forming terminals for motor leads and inter-connections between switches, all connections being thoroughly insulated by vulcabeston sleeves and washers.

A section of the individual switch units is shown by Fig. 3.

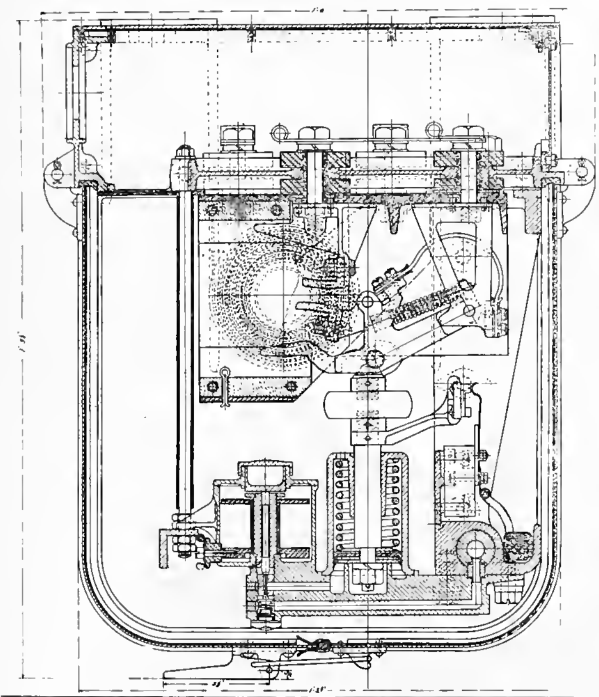


Fig. 3.

The interlocking switches consist of spring contact fingers sliding on segments and are electrically connected with the magnet valve in such manner that the closing of one switch energizes the magnet of the next succeeding one, thus producing automatic progressive action.

An exterior view of a single unit magnet valve is shown by Fig. 4.

When the magnet is energized its armature is attracted and opens valve from air reservoir to the cylinder. The air reservoir is supplied with air at 70 pounds pressure per square inch from the supplementary control reservoir. The piston making its stroke compresses the piston spring and closes the switch at the same time closing or opening the interlock contacts. When the magnet circuit is open the cylinder exhausts to atmosphere and switch opens through the action of the piston spring. It will be noted that the normal position of the switch is open, and the failure of the air supply or interruption of the circuit opens all the unit switches. The use of air gives great power for closing the switches and renders the operation of them entirely independent of fluctuations of line voltage. Curves shown in Fig. 5 give some data on the relation between carrying capacity and air pressure on the piston head exerted on the contact. A sheet iron

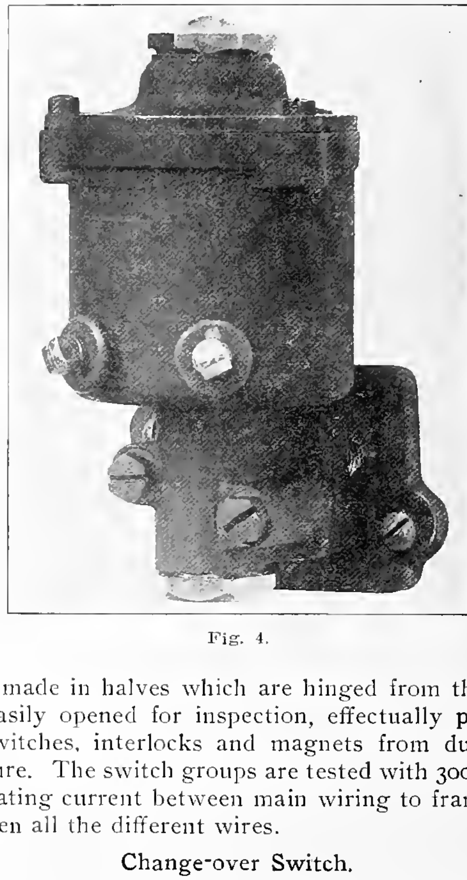


Fig. 4.

cover made in halves which are hinged from the base and easily opened for inspection, effectually protects the switches, interlocks and magnets from dust and moisture. The switch groups are tested with 3000 volts alternating current between main wiring to frame and between all the different wires.

Change-over Switch.

While the Northern Electric Railway's secondary distribution consists almost entirely of third rail construction, it was nevertheless necessary to install overhead trolleys where the line traverses cities and towns. This necessitated wiring arrangements of such a character that third rail shoes would be "dead" while equipment operated within town limits. The old method of attaining this result was either by the use of large knife blade switches, manually operated, or of third rail shoes manually lowered. Both of these systems are cumbersome and inconvenient. An automatic device known as a change-over switch was, therefore, developed for this service.

This change-over switch, an exterior view of which is shown by Fig. 6, consists briefly of a pair unit of electro-pneumatic valves operating pneumatically a block contact held in guides, and operated therein, wiping fingers in contact giving the desired changes in connections to either trolley or third rail circuits. This apparatus is entirely automatic and is operated and protected by two interlocking relays respectively con-

nected to trolley circuits and third rail circuits. The detail of these connections is shown in the "Diagram of Connection of Main and Control Wiring with Unit Switch Control," as shown on page 384.

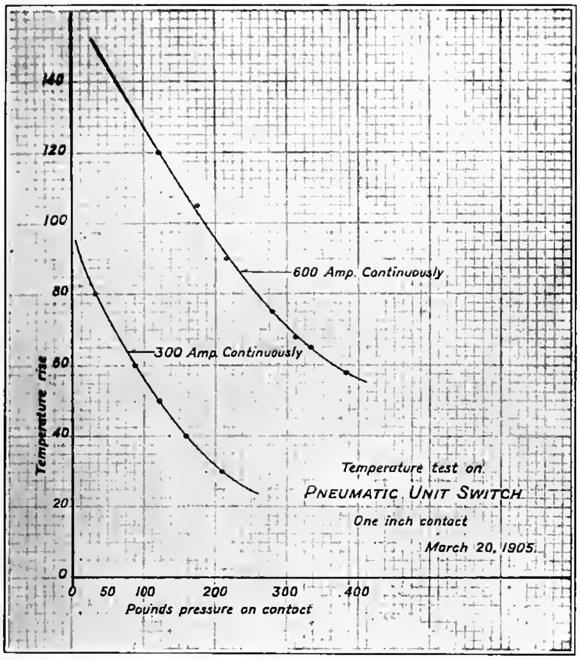


Fig. 5.

Line Switch.

Shown by Fig. 7 closed and by Fig 8 with covers removed.

Current from the trolley or third rail connections after passing through the change-over switch passes then through the line switch. The line switch is a single unit of identical construction with the switch group. It is an independent circuit-breaker provided with automatic overload trip, the trip consisting of a plunger acted upon by the blowout coil, the plunger opening a small switch in the control circuit. The trip is also provided with a resetting magnet, the whole being substantially protected by cast iron cap bolted to the main switch and plate.

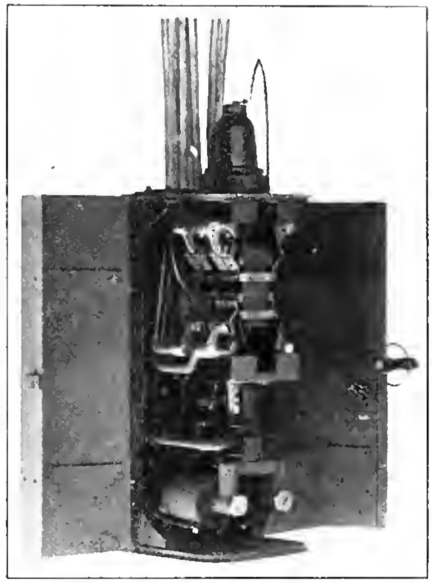


Fig. 6.

Reverse Switch

Shown by Fig. 9 with cover removed.

The function of the reverse switch is to interchange the armature leads of the motors with respect to the field, and thereby reverse the direction of rotation. It consists of two rows of stationary fingers connected through a contact drum rotated by the action of two air pistons, the admission of air being controlled by electro-pneumatic valves similar to those on the switch group and likewise operated from the controller. The drum may be manually moved to the "off" or "central" position. This arrangement is to open-circuit motors in case the car is being hauled. This open circuiting prevents motors from

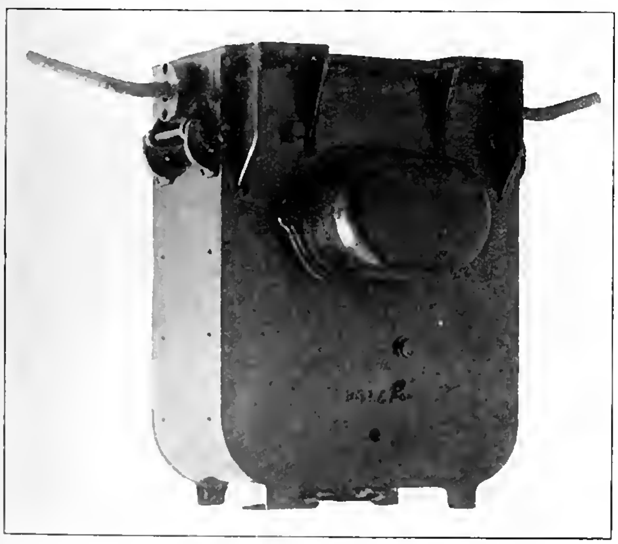


Fig. 7.

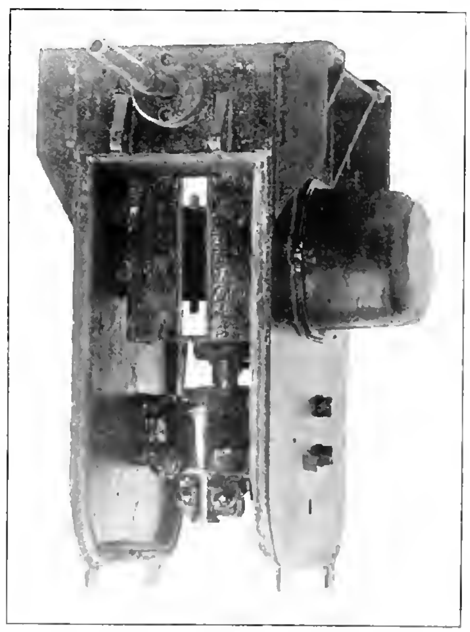


Fig. 8.

"bucking" or generating one into the other. There is also an interlock which acts so that the switch group cannot be operated unless the reverse switch is fully

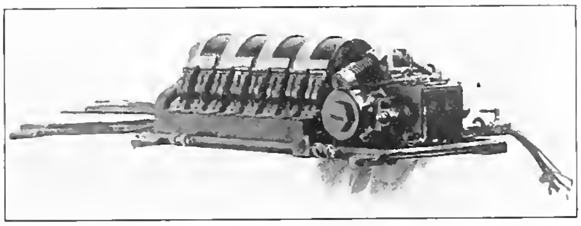


Fig. 9.

thrown in the direction indicated by the master controller, and an interlock closing the retaining circuit preventing reverser from opening while trolley circuit is closed on the motors.

Grid Resistances

Are of the unit type of grid diverters shown on Fig. 10 made up in boxes for facility in mounting and handling.

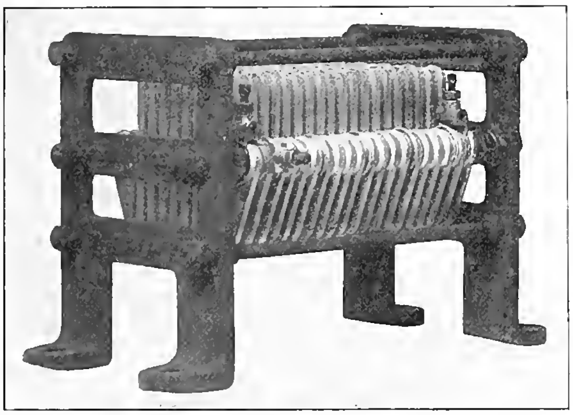


Fig. 10.

Master Controller.

The master controller shown on Fig. 11 is the governing type controlling the switch group and is located in the motorman's cab. It is of simple and compact construction, measuring approximately 7 inches high, 7 inches wide and 5 inches deep. It consists of a movable drum and stationary contact fingers which are electrically connected to the various magnet valves throughout the train. There are three positions for each direction of movement, the "off" position being in the center. These are:

(1) "Switching."
(2) "Series Running."
(3) "Multiple Running."

Intermediate positions of the unit switches can be secured by moving from the running positions. In the "off" position the drum is disconnected from all live wires. When the handle is thrown over without stop to any position; e. g., "Multiple Running," the switches follow in such a sequence that the car starts and is brought up to full speed at a uniform acceleration until full voltage is applied to the motors. This is done without current interruption to the motors at any time.

All current for the operation of unit switches passes through the particular master controller being operated, but control current for each motor-car is obtained from its own battery, so that the number of

Fig. 11.

cars that may be in a train is not limited. While the operating voltage is 14 volts only, these controllers are submitted to a shop test of 2000 volts alternating current.

Motor Control Cutout.

Shown with cover removed, Fig. 12.

This switch is hand operated and is designed to

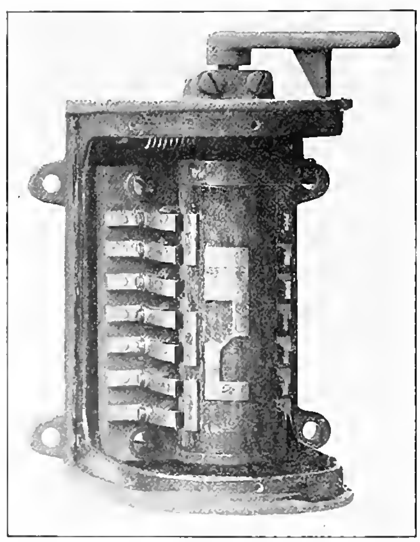


Fig. 12.

cut out operating circuits of certain unit switches, thereby cutting out either pair of motors should they

be disabled. There is an interlock provided which prevents the switch group from reaching the "Multiple" position except when all motors are in circuit.

Limit Switch.

This switch with cover removed shown by Fig. 13.

The rate at which the resistance is cut out of circuit so as to give uniform acceleration current, is

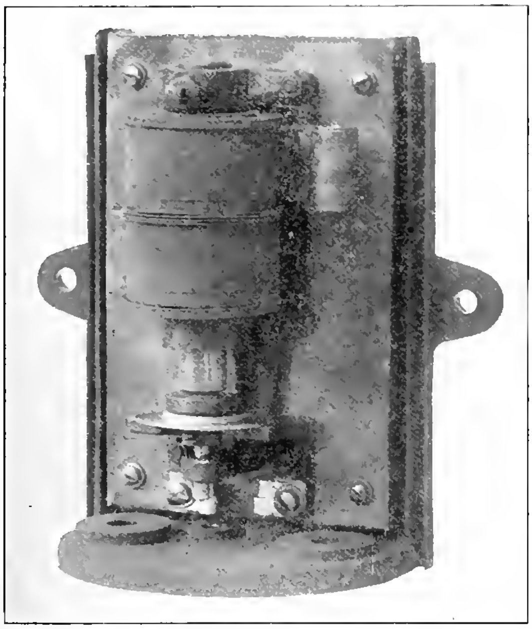


Fig. 13.

affected by the limit switch. This feature is a valuable one as it gives smooth and economical acceleration. It prevents abuse to equipment due to throwing on of power in excess of the predetermined rate.

The limit switch consists of a small switch actuated by a solenoid through the coil of which current of one pair of motors passes. When this current exceeds a predetermined limit for which the switch is adjusted, its armature is attracted against gravity, opening the switch which is connected in the operating circuit, and remains open so that no further unit switches can close (those already closed being retained) until the accelerating current falls below the predetermined limit. The armature then drops again completing the operating circuit and allowing the unit switches to continue their progression of closing. They are thus interrupted at each step of resistance. The limit switch can be adjusted to any desired accelerating current.

Line Relay.

This relay shown by Fig. 14 opens the unit switches should the current supply be interrupted. It consists of an electro-magnet, the coil of which is connected across the supply mains. The armature of this magnet acting against gravity holds three contacts closed in the operating circuit.

Another important function of this device is its interruption of control at third rail gaps and crossings which "drops out" the switch group contactors. Its return to normal when third rail shoes are again in contact with conductor rail restores the switch group control circuits so that the switch group "notches up" progressively restoring the controller connections within the period of a few seconds to the original position. If it were not for this relay interposed in the control circuits full voltage would be impressed upon motors immediately after passing a third rail gap. This sudden rush of current with its allied

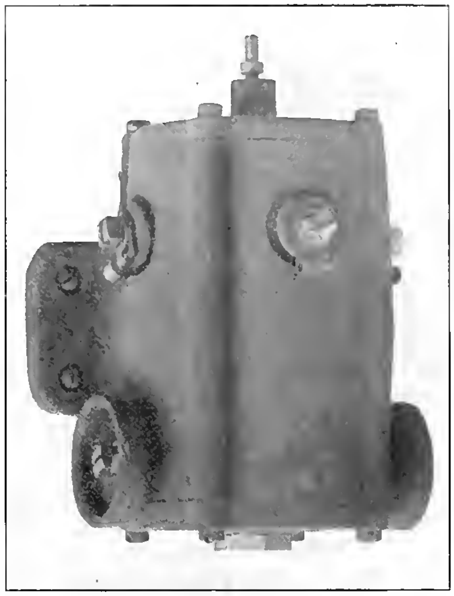


Fig. 14.

magnetic inductive surge would open breakers in sub-stations and otherwise abuse motors and generating apparatus.

Junction Boxes.

Fig. 15 shows a typical view of the cast iron junction boxes in which are enclosed wooden blocks having the requisite number of terminals for control wire connections.

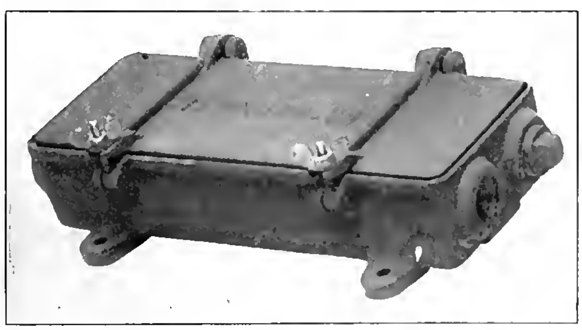
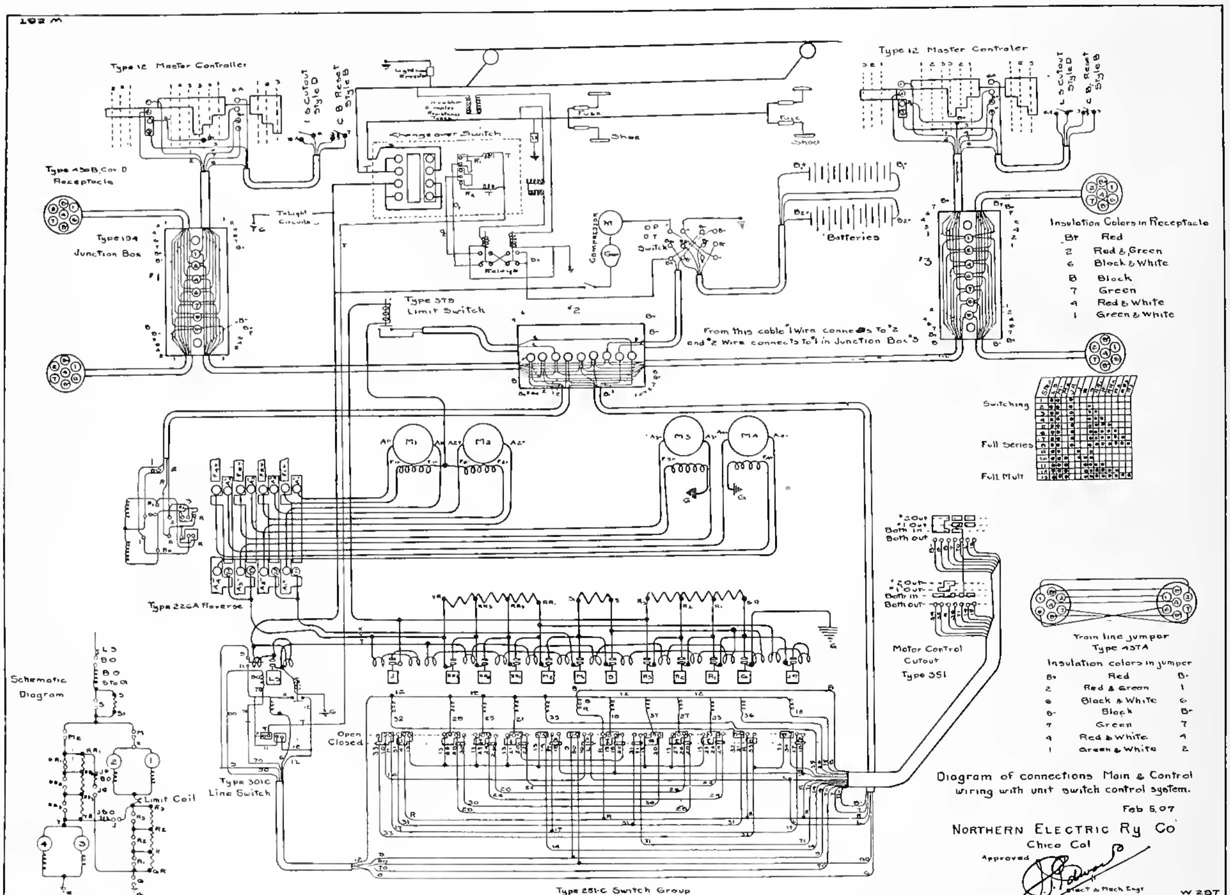
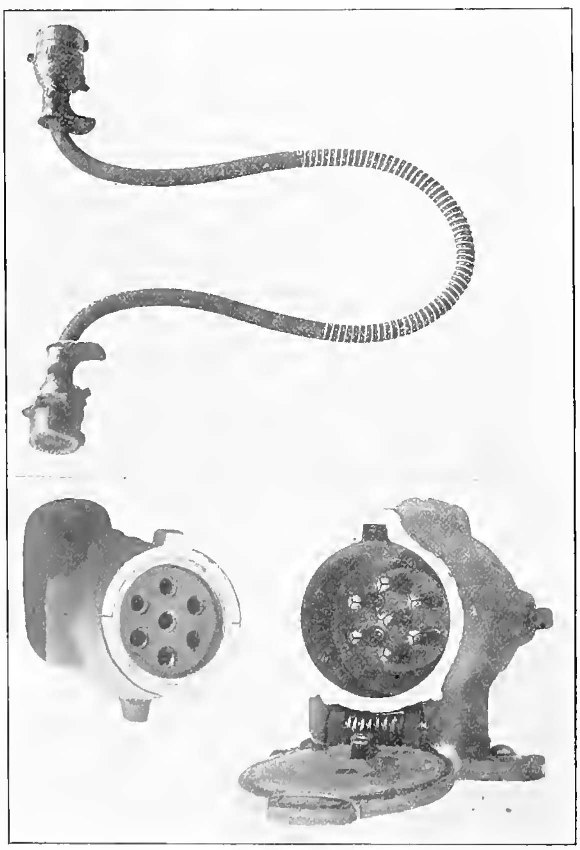


Fig. 15.

Train Line Receptacles.

As illustrated by Fig. 16 are used in train service and are employed to complete the control line bus connections between cars. The usual location of train line receptacles in which train line jumpers, as illustrated by Fig. 17, are located is slightly above the buffers upon one side of the cab. Because of the necessity of negotiating short radius curves in train service, this location was found undesirable and the





Figs. 16 and 17.

train line receptacles have been made an integral part of the radial draft rigging. These receptacles move together with the couplers. Details of this arrangement and a description of the same has been given in another portion of the "Journal of Electricity."

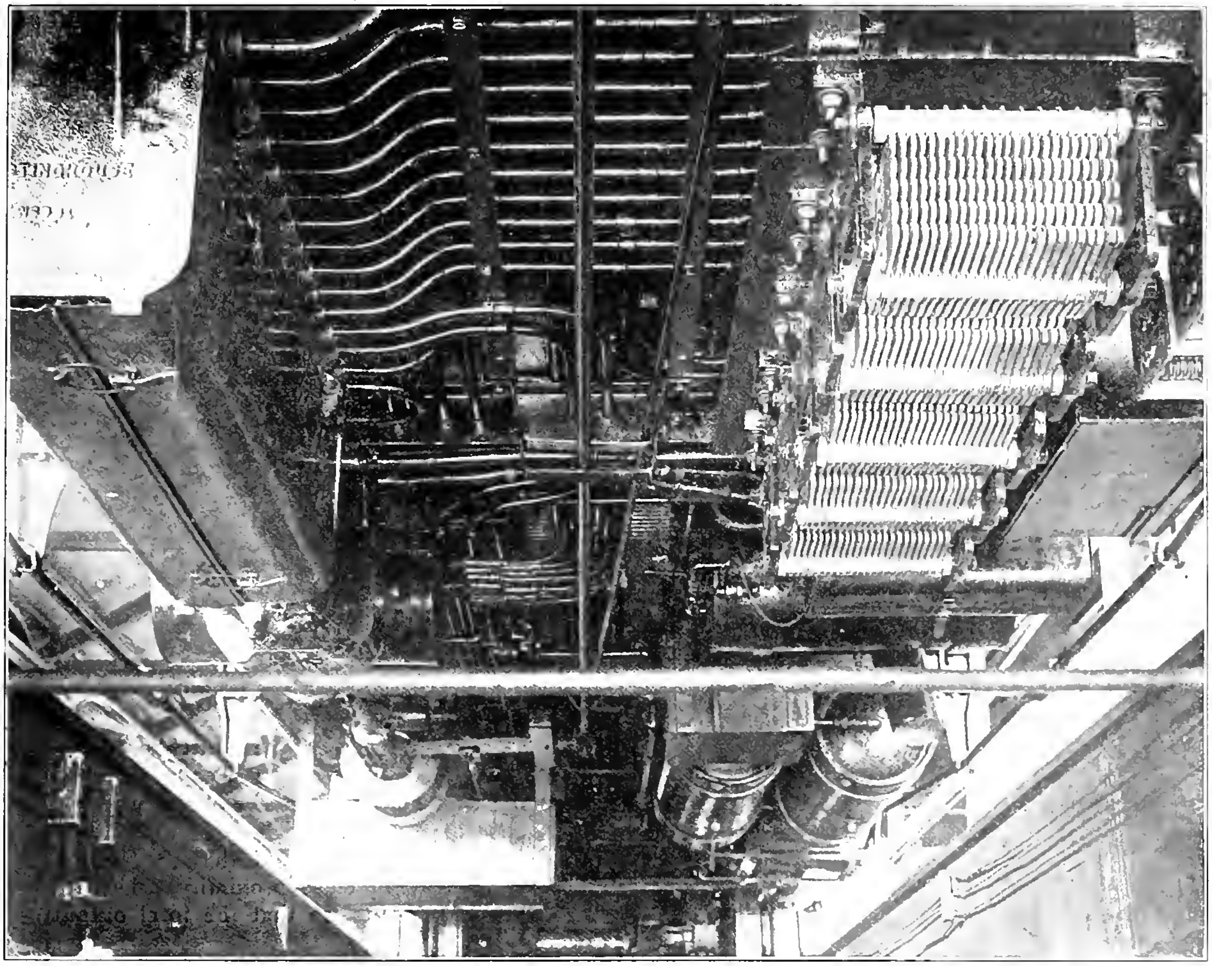
Storage Batteries.

Current for the operation of the magnet valves is secured from a storage battery in duplicate, each consisting of seven cells, having a capacity of 20 ampere-hours. One battery is on charge in series with interior arc lights, while the other is on the operating circuit, these connections being made by two double-pole, double-throw switches.

The batteries of each car are connected to two common leads, which are extended through the entire train as positive and negative of the train line. This connects the batteries of the different cars in parallel. The negative side is also connected to one side of the magnet valves on the same car, making the demand on the battery more or less local.

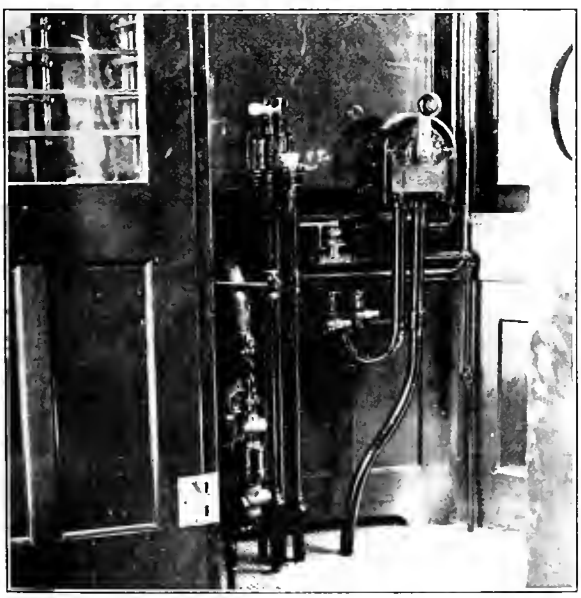
Line Switch Cutout and Circuit-Breaker Reset Switch.

These are two small knife switches located near the controller and conveniently within reach of the operator. By opening the line switch cutout the initial energizing of the control train circuits is opened and none of the line switches throughout the train can close. In this open position of the line switch cutout the switch groups of a train may be operated through their cycles for purposes of test. In a similar manner reversers may be thrown and an emergency braking



Under-Side of Coach Showing the Electro-Pneumatic Control and Air-Brake Systems.

effect secured. This entirely independent of line current or circuits.



Control Apparatus in a Motorman's Cab.

The circuit-breaker reset switch is nominally held open by a spring. The overload trip on the line switch is provided with a catch which, when the switch has been opened by a short circuit or other excessive current disturbance, holds it at that position, keeping the operating circuit open on that car with the master controller in the "off" position. The closing of the reset switch completes the circuit through a magnet, which withdraws the catch from the overload trip allowing the circuit breaker contacts to close.

General.

The control apparatus as above described has been in operation on the lines of the Northern Electric Railway for the past three years. The same has given complete satisfaction and by its performance in service has proven the correctness of its details of design and capacity for continuous operation under the exacting conditions of service required of it.

Sub-stations and Electrical Supply.

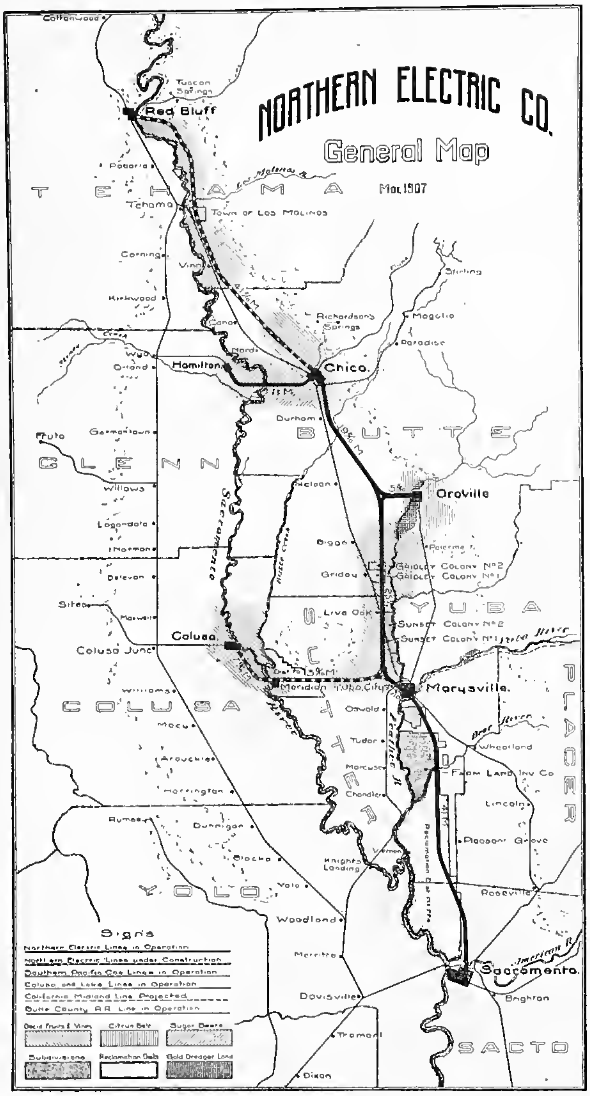
With an electric railroad, the question of a power supply is paramount. One of the features which made this project feasible was the abundant supply of low priced electrical energy, generated by hydraulic power in the nearby mountains, which was available at all points in this system. The question of expensive steam generating plants did not enter into the problem and it was not even necessary to parallel the road with a high-tension distributing line, although this has been partially done.

Electric power is supplied at the low-tension side of the transformers by the Pacific Gas & Electric Company who own and furnish the transformers and high-tension apparatus necessary for use at the sub-stations. All other sub-station equipment, including the buildings themselves are owned by the Northern Electric Company.

There are three standard types of sub-stations in use, which have been designed and built by the engineers of the company. These are distributed so as to energize about 10 miles of road each.

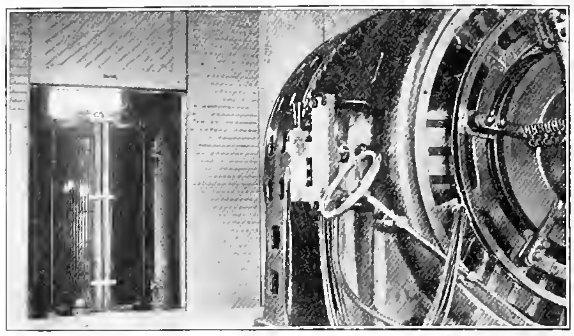
There are at present nine stations, although provision has been made for ten and they are numbered accordingly.

The equipment throughout is similar, both in the type and size of the motor-generator sets and style of switchboard.



Current is supplied from the transmission lines at a potential of 60,000 volts, with a frequency of 60 cycles. It is supplied to the motors at 2000 volts.

Motor-generators were adopted instead of rotary converters, for a variety of reasons; they consist of a Westinghouse, type CCL induction motor, rated at 580 hp., direct connected to a Westinghouse, 6-pole, 600 volt generator of 400 kilowatts capacity. The two machines are set close together, are mounted on a single base, and have but two bearings. This arrangement presents a neat appearance and the machines have proven themselves dependable and highly efficient.



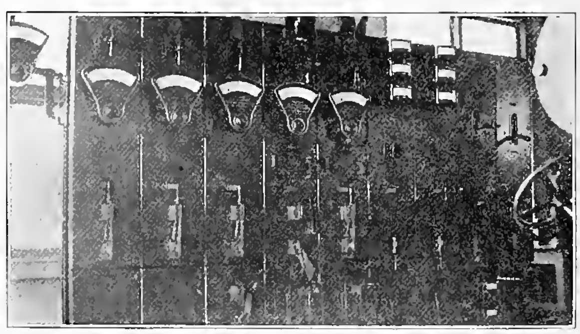
Machines and Transformers, Sub-Station No. 2.

The switchboards are of slate of the standard General Electric type for this purpose and the instruments and switches are of the same make. The switchboards were assembled and the mountings made by the Northern Electric engineers in accordance with their own ideas.

Connection between the switchboard and track are made with 1,000,000 cir. mil copper cable.

The first station is, as before mentioned, at the car house at Mulberry. There are no transformers, as current is supplied from the sub-station of the power company in close proximity. There are two motor-generator sets, so that the total output is 800 kilowatts.

Number 2 is 9.4 miles from Mulberry. It represents one of the types of sub-station buildings adopted by the company. The building is almost square; it has a concrete foundation under the walls, transformers and machines. Provision is made to rapidly drain the transformers of their oil, should a burn-out occur and in carrying out this idea a system of ducts has been incorporated so as to cause a natural draught of air, drawn from beneath the building and next to the ground, where it will be coolest, to pass up



A Sub-Station's Switchboard.

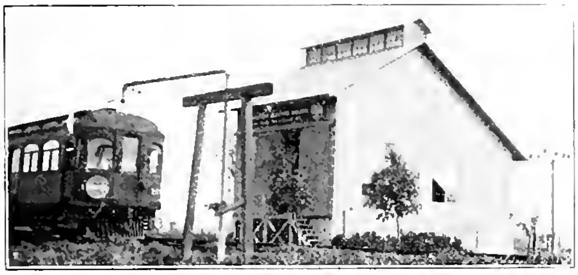
and around the transformer cases and out through special transformer cell ventilators.

The switchboard is mounted well away from the wall and behind it is an elongated pit through which all cables are carried; this is covered with a grated wood floor. The oil-switch for the induction motor is

of the remote control, manually operated type and is contained in a fire-proof enclosure, outside of the building.

The framework of the building is of wood, but it is covered with wire lath which is also used for the panel walls. Two coats of cement plaster both inside and out cover the lath, making a thoroughly serviceable and practically fire-proof building.

At No. 2 station there is but one motor-generator set. There are three, 150 kw. transformers.



Sub-Station No. 4.

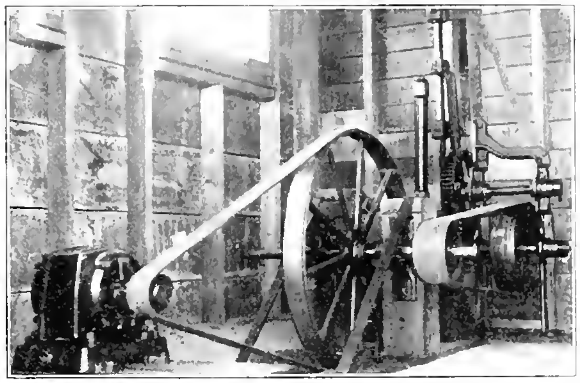
The transformers may be moved forward out of their cells, but ordinarily the opening between the cell and the operating room is closed by a counterweighted sliding door.

Sub-station No. 3 is at Tres Vias and energizes, not only a section of the main line, but the branch into Oroville as well. This station is similar to No. 2 in all respects, except that the transformers are 300 kw. capacity each, and there are two 400 kw. motor-generator sets.

Sub-station No. 4 is again similar to No.'s 2 and 3 and is equipped with one motor-generator set. This station is located near Gridley.

At all the sub-stations, it is necessary to have water for the various purposes of domestic supply, irrigation and as a means for cooling transformers, although some of the transformers are oil-immersed but air-cooled. Water is near the surface of the ground at almost any point, but it is necessary to pump it. A tank elevated to give the proper head for all purposes is supplied from the well by a simple but dependable pumping rig. This is installed in a small pump house near the station and operated by the attendant, whenever necessary.

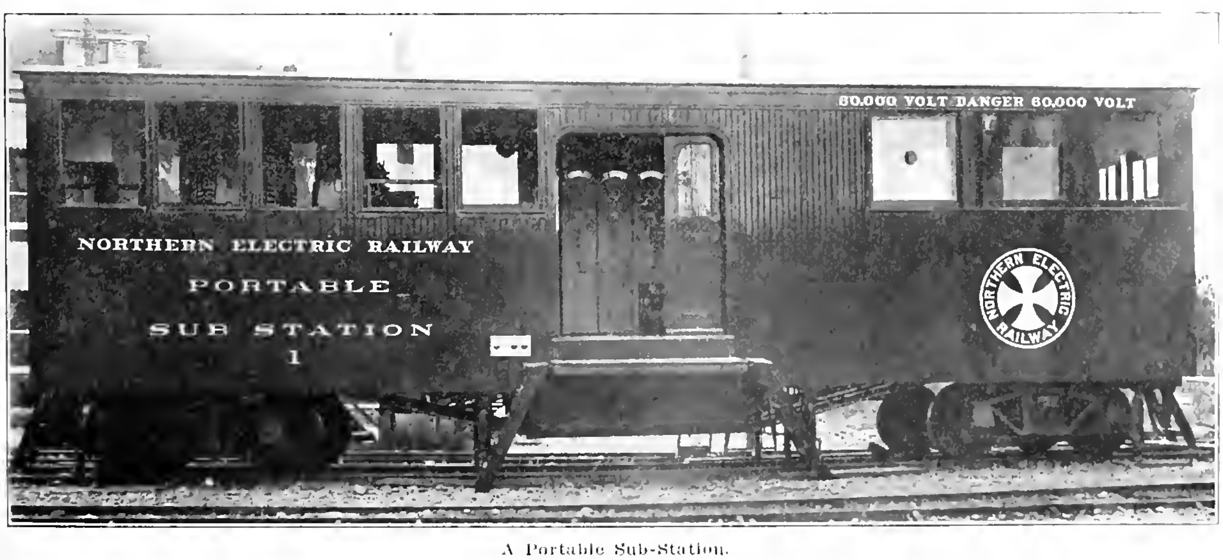
No. 5 sub-station represents another type in that it is portable. This consists of two standard freight cars, reconstructed however throughout for the purpose.



Pumping Rig at Sub-Station No. 4.

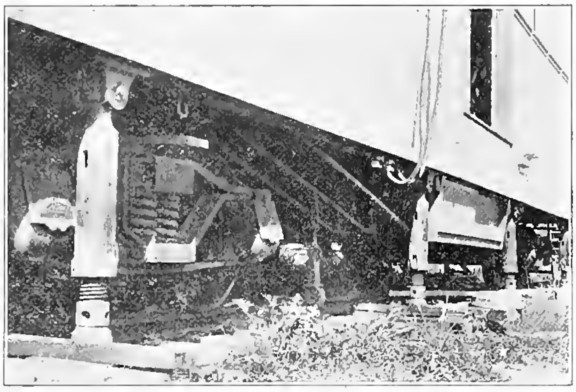
One of the cars contains three 150 kw. lowering transformers. The high-tension lines are brought into the car through three windows. These are 36 in. square and have two glass panes each, the wire passing through a hole at the centre of the pane. High-tension disconnecting switches are mounted on poles outside of the car.

The sub-station proper contains one standard 400 kw. set and the accompanying switchboard. One end is partitioned off to make a tool room. This station being mounted on wheels, it is very important that it shall not only be level, but also not subject to vibration. This is accomplished by means of wrought-iron hooks fastened to the under side of the car-body and which grip the ball of the rails. Acting against the strain imparted by these hooks are screw jacks, which bear up against the car-body. The accompanying illustration shows the simplicity of this device and the clearness of the view of the interior, which was made while the machines were in regular operation, proves their effectiveness.



A Portable Sub-Station.

Sub-station No. 6 is in the city of Marysville. Current is supplied from the local station of the Pacific Gas & Electric Company, there are therefore no transformers. This station is similar to Nos. 2, 3 and 4, it is equipped with two motor-generators, but differs in the arrangement of the machines, in that, while the building was originally designed for but one machine set, another was subsequently added by invading two of the spaces reserved for transformers, and setting the machine at 90 degrees in respect to the first one.

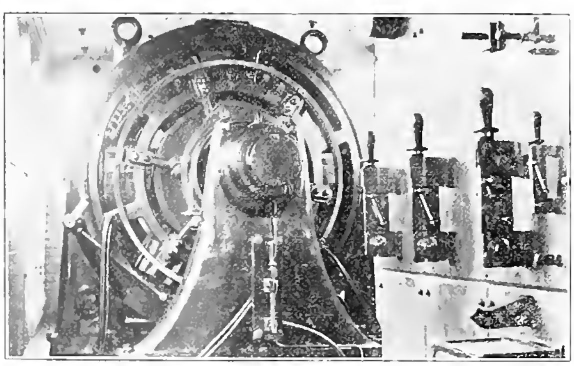


Method of Fastening a Portable Sub-Station to the Track.

There is as yet no sub-station numbered 7 and the gap between Marysville and Nicolous, where No. 8 is located is 16 miles.

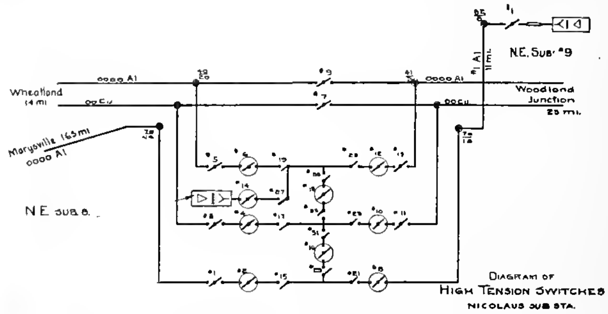
No. 8 sub-station is the newest and most complete of any yet built. It has a steel frame and the roof which consists of reinforced concrete slabs, is supported on steel trusses. The walls are of reinforced concrete construction. The building has a main floor on which are placed the transformers and two 400 kw. motor-generator sets, arranged much as in the older stations; there is also a second or gallery floor, this contains compartments and high-tension oil switches and is in reality a sectionalizing house for the power company and a switching house to enable this station to derive its source of electrical supply from any one of three transmission lines.

The main, double transmission line of the Pacific Gas & Electric Company between Colgate and Oakland passes through this station. A transmission line of the same company from Marysville, paralleling the road also comes to this station and continues to sub-station No. 9. With this arrangement of switches and disconnecting switches which are mounted on poles, outside of the building, current may be taken from the Marysville line or from either of the Bay lines.



Interior of a Portable Sub-Station.

The following diagram shows the arrangements of these circuits:



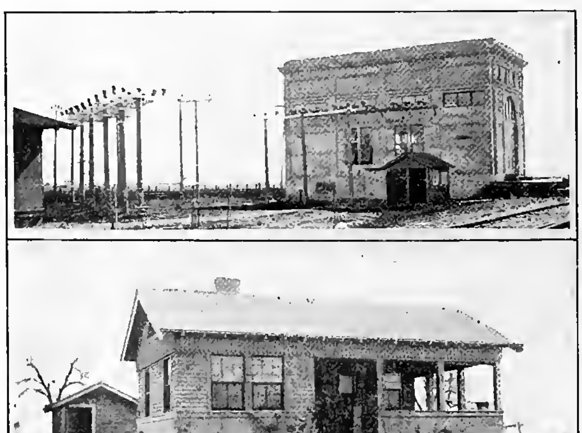
Sub-station No. 9 is of the portable type and is about half way between Nicolous and Sacramento. It is similar in all respects to No. 5.

The last source of energy is at Sacramento. This is derived from the sub-station of the Pacific Gas & Electric Company at 6th., & H Sts. There is one motor-generator set similar to all of the others in use and this is owned by the Northern Electric Company.

The total installed capacity of the sub-stations is 5,200 kilowatts.

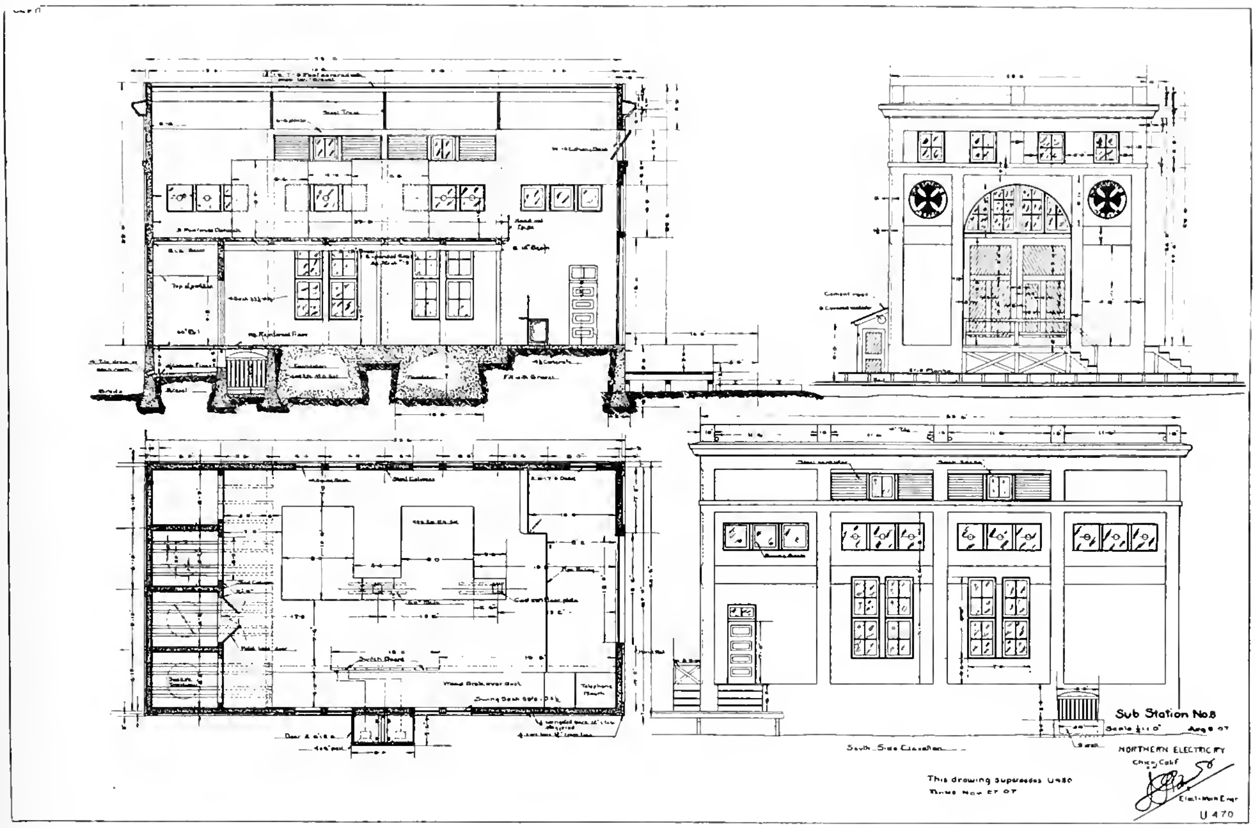
The cost of two sub-stations (not including transformers and high-tension switches, which are the property of the power company), representing the two stationary types, is as follows:

	No. 4.		No. 8.
Capacity	400 kw.		800 kw.
Cost.			
Property	$ 400		$ 250
Foundation	3,100		1,850
Building Superstructure	"	(inc.)	6,400
Electrical Machinery	6,600		13,200
Switchboard	1,500		3,000
Pumping Plant	160		180
Tank	690		300
Erection of Machinery and Installation.	500		1,000
Cartage	1,200		600
Incidental Expense	300		750
Total	$14,450		$27,530



1. North Side of Nicolaus Sub-Station.
2. Type of Cottage for Sub-Station Operators.

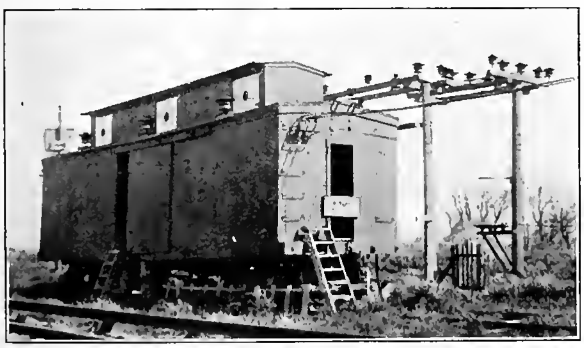
Electricity supplied from the transmission system is measured on the alternating side of the motor-



generators. For this reason all calculations of efficiency and losses between the power supplied and the trains are based on these measurements.

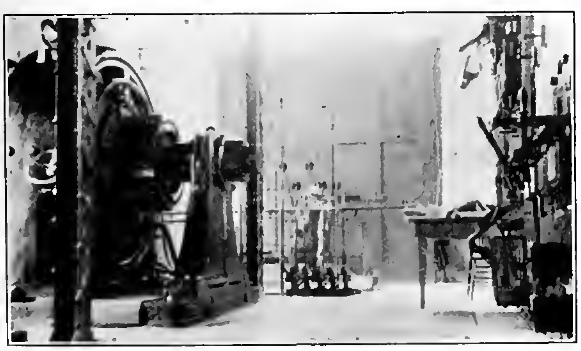
The motor-generators are operated in such a manner as to pick up the load as it comes on, thus maintaining a high converting efficiency at all times.

The efficiency of transformation from the alternating current side of the motor-generators to the

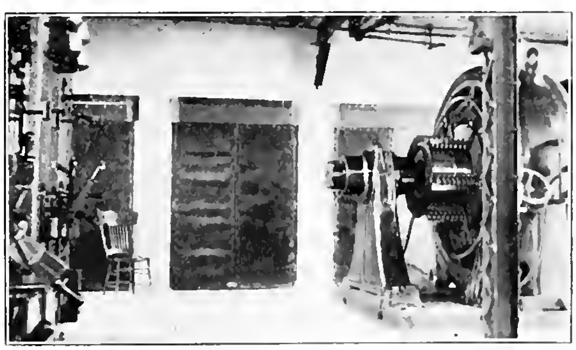


Portable Transformer Station.

Sub-Station No. 8 at Nicolaus.



Machines, Switchboard and High Tension Switch-Levers in Sub-Station No. 8.



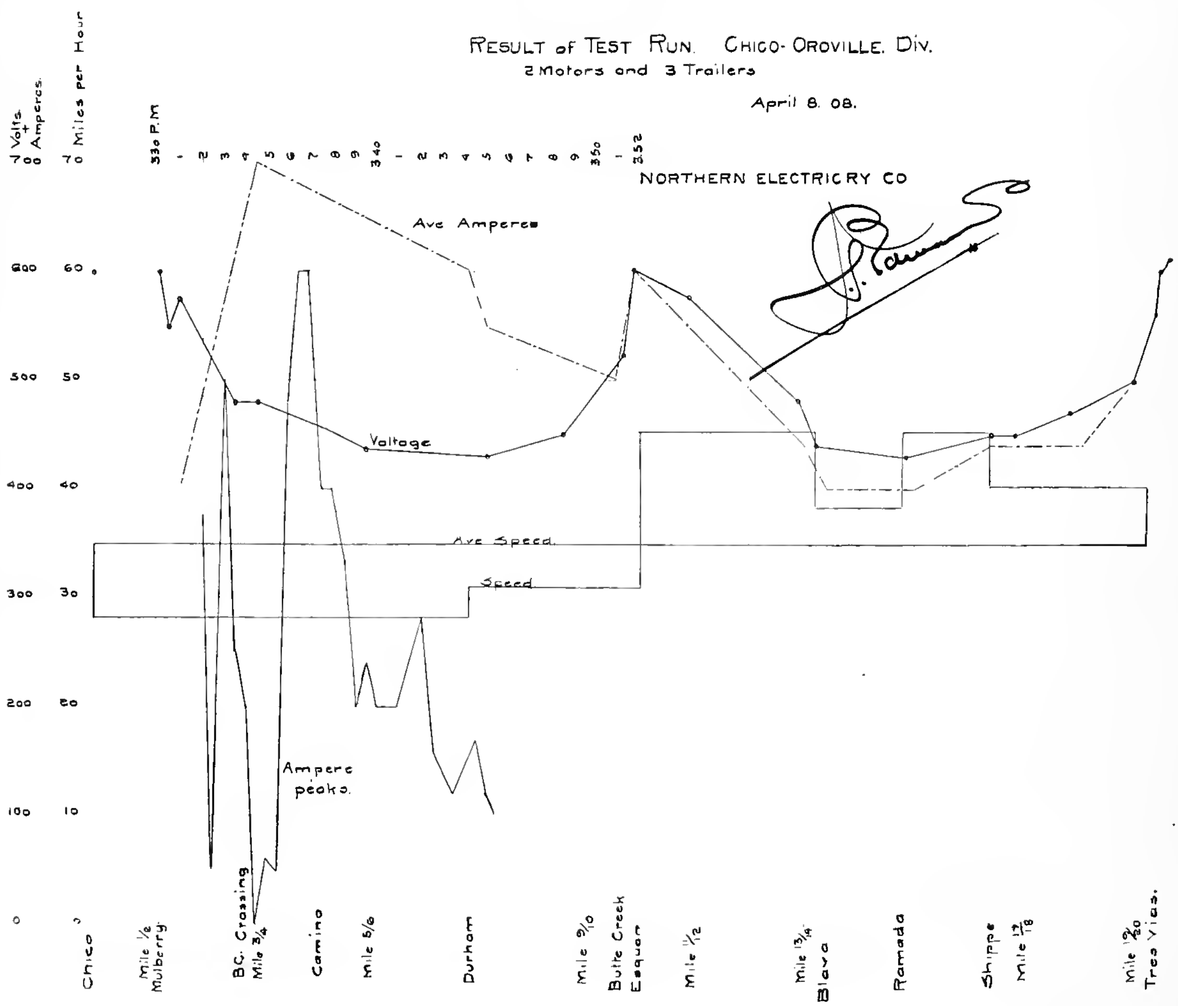
Machines, Switchboard and Transformer Cells in Sub-Station No. 8.

direct current at the switchboard varies in different stations, due to the character of the load, from 50 to 80 per cent. The average for all sub-stations is 66 per cent.

The distribution losses between the direct current switchboard and the train, taking an average from all points, is 6.05 per cent.

The amount of power consumed per car mile, taken from data covering the year 1909, measured at the alternating current side of the motor-generators, is 4,266 watthours. The consumption of power, measured as before, per ton mile, for passenger train service, is 113 watthours. The actual consumption of the direct current at the train is 69.73 watthours per ton mile. During an average day there is run a total of 1500 car miles.

Following are diagrams showing the results of test runs, giving the time between stations, current consumed, etc.



Train Operation.

As a rule all trains consist of two or more cars. The first is a combination baggage and smoking car and the second a passenger car. If more than two cars are used, a trailer passenger car is placed in the center of the train. For short runs, where there is need of but one car, a combination baggage, smoking and passenger car is used.

Through trains are run at an interval of about 2½ hours throughout the day and evening. The running time from terminal to terminal is three hours.

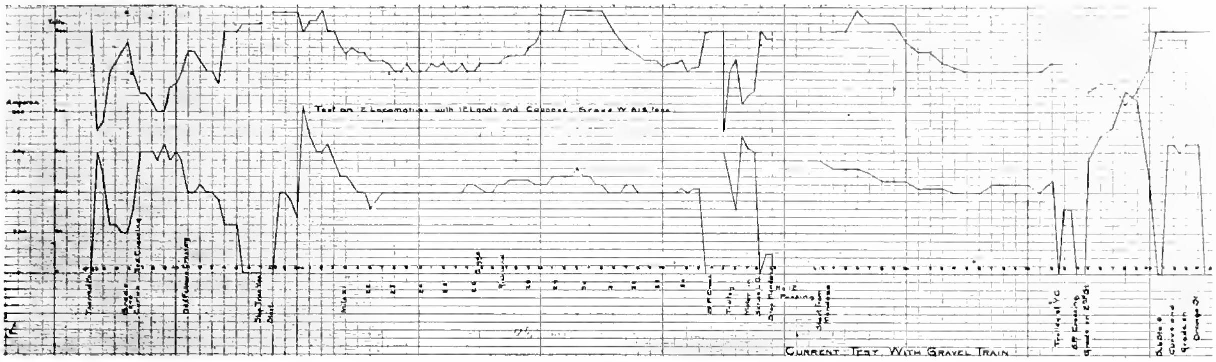
All trains are manned by a motorman, conductor and one brakeman.

A private telegraph and telephone system extends the length of the road, the poles being placed 3 ft. from the western edge of the right of way.

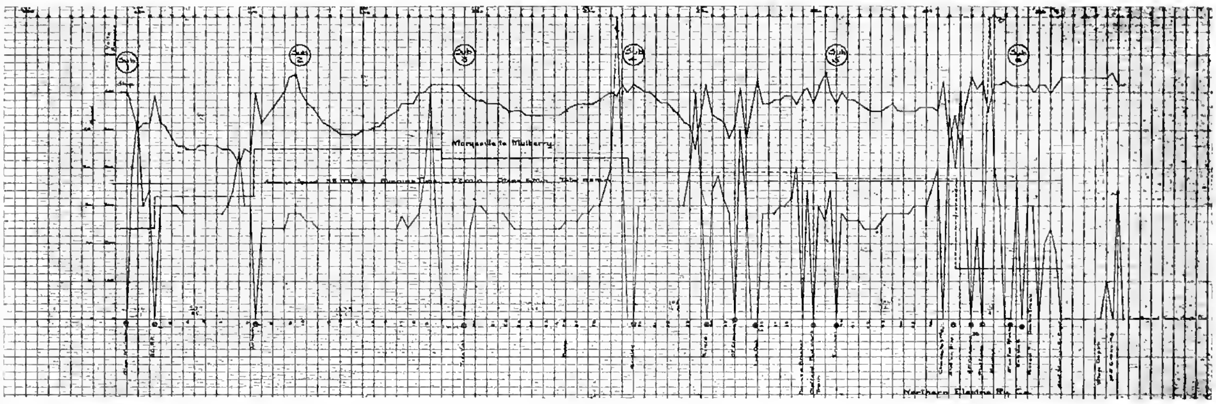
The operating offices, including that of the Chief Dispatcher, are at Mulberry (Chico). Offices having telegraph operators are at Durham, Tres Vias, Thermolito, Oroville, Live Oak, Yuba City, Marysville, Nicolous and Sacramento. At these points train orders are issued.

The road is operated in accordance with Standard American Railway Practice Rules; train order forms "19" and "31" being used.

Throughout the day and the early evening, the road is given over entirely to passenger traffic. Between the hours of midnight and 6 o'clock a. m., all freight transportation is accomplished. Were it not for the possibility of this arrangement, the fast and frequent passenger schedules could not be maintained



Running Test of Freight Train Between Marysville and Mulberry.



Running Test Between Marysville and Mulberry of Passenger Train.

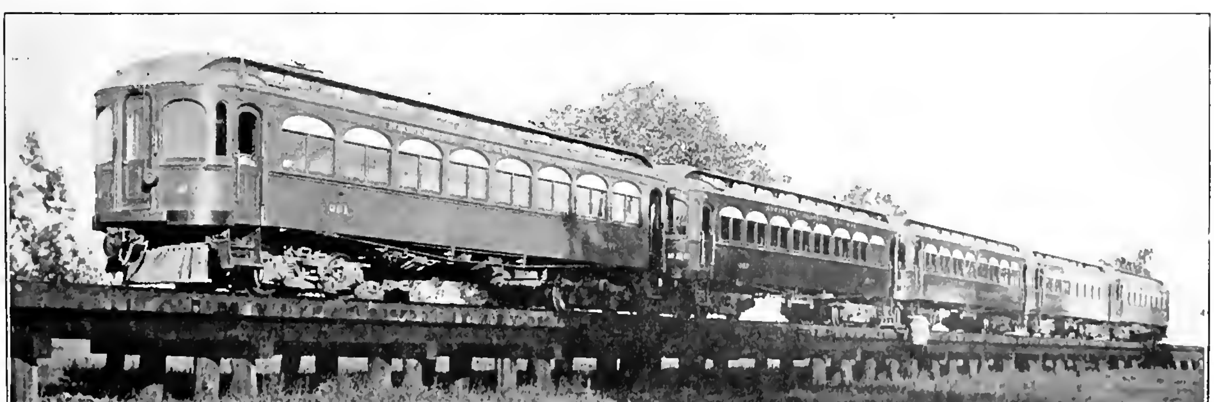
without seriously inconveniencing freight traffic which is rapidly increasing in importance.

The Northern Electric Company has the distinction of being a thoroughly California corporation; that is, it was founded and is owned and operated by California interests.

The executive offices are at San Francisco; the president is Mr. E. R. Lilienthal; the vice-president, Mr. Louis Sloss, and the secretary, Mr. Norman Logan.

The actual operation of the system is under the supervision of the general manager and purchasing agent, Mr. A. D. Schindler, whose office is in San Francisco, and who is responsible for the admirable results obtained. He has an able assistant in Mr. Melville Dozier, whose headquarters are at Mulberry. Mr. J. P. Edwards is, as before stated, the electrical and mechanical engineer, and to him is due the credit of the design and construction of the varous electrical and mechanical features.

All of these gentlemen have given the writer every assistance possible in his attempt to make an accurate and creditable description of this system, of which all Californians may feel proud.



Five-Car Northern Electric Train.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER VI.

MISCELLANEOUS.

(Continued.)

The Pre-Payment Watthour Meter.

The prepayment device as applied to the gas meter has demonstrated its usefulness after a number of years of service, it being especially valuable in cities where many of the consumers are transient residents, and also where those served find it a burden to make the usual monthly payments, preferring to pay as occasion demands. The slow introduction of prepayment electric meters has been partly due to the limited demand, because usually the class of people that have been using electricity for light, power, heating and cooking have not been of the kind that would desire or that would necessitate the installation of prepayment meters. Now electricity occupies such a broad field that it may be said to be used by all classes of people, therefore the distributing company is often confronted with the problem of "slow pay" customers. Especially is this true with small commercial establishments, such as the poorer classes of restaurants, saloons, tailor shops, etc. The prepayment meter when installed in such places will oftentimes obviate difficulties which may otherwise arise.

The prepayment device can be furnished either as an integral part of the watthour meter, or as a separate device. The construction and operation in either case is essentially the same, except that in the former case the connection to the meter is mechanical and in the latter case it is electrical. Fig. 73 illustrates the prepayment device attached directly to the watthour meter, in which case a pinion in the registering mechanism of the meter meshes directly with the debiting mechanism of the device. In case the prepayment device is used separately from the watthour meter, the debiting mechanism is controlled by an electromagnet which is connected directly in the line, contact being made through suitable gears and commutating device in the meter register.

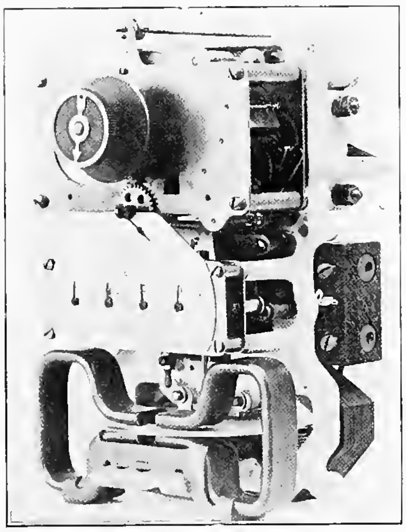


Fig. 73.

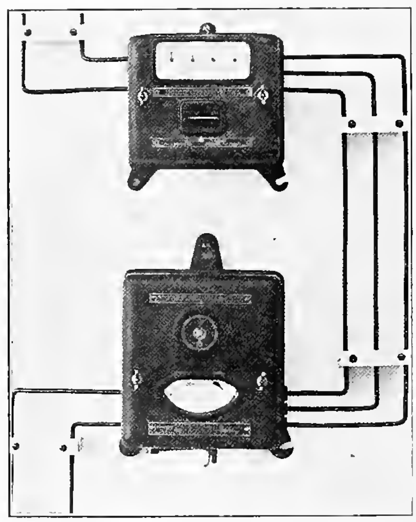


Fig. 74.

Fig. 74 shows the prepayment device when used as a separate part of a watthour meter.

Construction and Operation.

The small knob shown protruding from the front of the case is provided with a slot for the reception of coins of the proper denomination. After the coin is placed in the slot the knob is given a half turn to the right, the coin engaging the shaft of the crediting mechanism and the main circuit being simultaneously closed. The coin is carried around with the turn of the knob and released into a chute which conveys it to a coin chamber in the base of the meter. The first coin placed in the slot will cause the indicating hand to move to the figure "1" on the crediting dial, the second coin will cause the hand to move to the figure "2," and so on, provision usually being made to accommodate twelve quarter dollar coins at once. Thus $3.00 worth of current may be paid for in advance, and as each quarter's worth is used, the debiting mechanism will cause the indicating hand to recede to the next figure. The dial, therefore, only indicates the number of coins to the credit of the consumer and does not take into account the coins for which energy has already been delivered. The total number of coins placed in the device can always be readily translated from the watthour register by multiplying the reading in kilowatt hours by the rate per kilowatt and dividing the result by the denomination of the coin. When all the energy which has been paid for has been delivered, the crediting hand moves back to the zero position and opens an internal switch, which cannot be again closed until another coin is deposited. The switch contacts are made of laminated copper strips which insure good electrical contact.

The force which actuates the debiting device consists of a large spiral spring. This spring exerts practically a constant force, since it is so designed that it is always operating under a low percentage of its maximum tension. The gearing mechanism of the spring is "differential" in operation, so that the escapement is independent of the knob. This permits the consumer to place more coins in the device before all energy paid for has been delivered, without in any

way disturbing the crediting and debiting mechanism. The prepayment device is usually made for rates ranging from 5 to 20 cents per kilowatt-hour in steps of one-half cent. Each prepayment device is marked with the rate per kilowatt-hour with which it should be used; if, however, it is desired to change this rate of charge it is only necessary to change the gear ratio of the "rate device," the construction being such that this is easily accomplished. The coin receptacle is in the back of the meter and so located and protected that the meter cover may be removed (for testing and inspection), without giving access to the coin receptacle. It consists of a drawer which can be slipped in or out from the bottom of the meter case, so that it is not necessary for the collector to remove the meter cover when taking out the coin. Lugs (as will be seen from the illustration) are furnished so that the coin receptacle can be locked by means of a suitable padlock.

The manufacturing companies have perfected the prepayment device to such a degree that it is as trustworthy as the gas meter device, and they have designed it so that "beating" is practically impossible. When a coin is once placed in the slot, the knob cannot be turned back until a half turn has been completed and the coin has dropped into the chute. A coin of smaller dimensions than that for which the slot is designed will not allow the knob to be turned. The credit knob is provided internally with a sharp edge which will shear off any thread or fine wire that may have been attached to the coin with fraudulent intentions.

The prepayment attachment for the electric meter has the advantage over the gas device in that it may be placed at any point remote from the meter which it controls. The electric meter may be in the attic, the basement or on the back porch, and the prepayment device in the kitchen or other convenient place.

The following diagrams show the connections of the prepayment device above described when used in connection with alternating and direct current watthour meters as manufactured by the General Electric Company.

The Wright Demand Indicator.

The need of an instrument which will indicate the maximum demand made upon the current supply of a distributing company has lead to the development of the device shown in Fig. 76, which is known as the "Wright Demand Indicator." As will be noted from Chapter VIII, relative to rates, the cost of serving a customer whose average load for 24 hours, compared with his maximum, is high, will be lower than the cost of serving a customer the ratio of whose average to maximum load is low. In other words, the customer with a good "load factor" is more profitable to the distributing company. For example, suppose that a given customer has a connected load of lamps amounting to 10 kw. which are being supplied with current for only two hours in the evening, and suppose that another customer has a connected load of motors amounting to 2 kw. that takes current for ten hours. In either case, the kilowatt-hours per day are the same, but the lighting load comes when the demand upon the station is at the highest point; whereas, the motor customer is being served when the generating machinery would otherwise be running partially loaded. It is therefore evident that the customer whose demand is practically constant, such as the motor customer, is the most profitable, and is entitled to a better rate.

The Wright Demand Indicator can be, and is used to great advantage in determining the maximum load on transformers. Its systematic use in determining the actual maximum loads on the transformers of a distributing system will insure the transformers against excessive overloads. As is the case with meters, it is not infrequent that transformers of too large a capacity are used for supplying a given connected load; the maximum demand indicator is valuable in determining the proper capacity of distributing transformers. The indicator may be mounted on the pole and connected in the circuit by replacing one of the primary fuse-plugs with the plug having loose connections which are attached to the terminals of the indicator. When the indicator is used in this way it should be mounted on a suitable board, which will

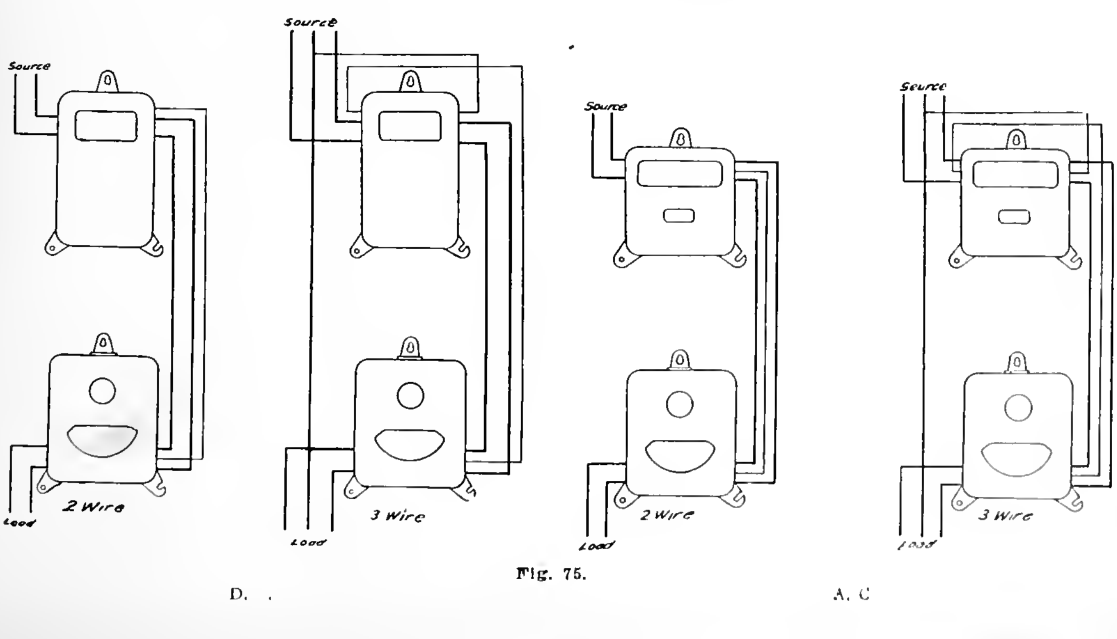


Fig. 75.

D. C. A. C.

facilitate handling and also prevent breakage. The indicator can also be applied to motors driving machine tools, etc., to ascertain whether or not they are being operated in excess of their guarantees.

Around the upper, or left hand bulb, shown in Fig. 76, and in close thermal contact with it, is a band of resistance wire through which passes the main line current or a proportionate part thereof; shunts being provided with high capacity direct current indicators.

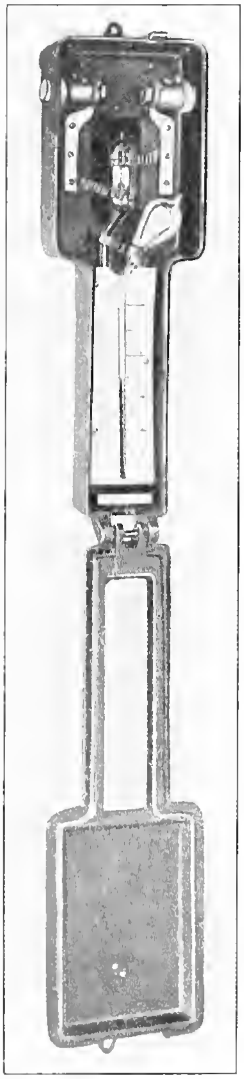


Fig. 76.

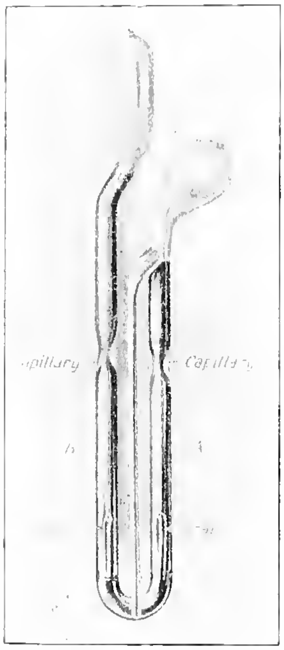


Fig. 77.

and current transformers with the larger sizes for use on alternating current circuits. The current in passing through the resistance band heats the air in the glass bulb, which in turn causes the air to expand, thereby forcing the liquid up into the right-hand tube, the liquid then falling into the central or index tube, which is set in front of the scale. The heat generated in the resistance band is proportional to the square of the current passing through it (watts dissipated in resistance = resistance X the square of the current flowing).

The difference in temperature of the air in the two bulbs causes the liquid to flow as it does, and since any external temperature affects the air in the two bulbs similarly, no error will result due to changes in temperature of the surrounding air.

The tube is reset by simply tilting it and allowing the liquid to flow out of the index tube back in to the U tube. In resetting the indicator, air bubbles from one arm of the U may be carried over into the other arm, thereby unequalizing the pressure and causing the calibration to be disturbed. To prevent this trouble, the little traps shown in the illustration are located in the bottom of the U, and when the tube is inverted (or partially so), they remain covered with the liquid, due to the action of the capillaries in the channels of the U tube, and thereby prevent the passage of air from one side of the U to the other side.

The Induction Type Watt Demand Indicator.

The Wright Demand Indicator which has just been described deals with the current only, and does not take into consideration the power factor of the circuit on which it is used nor fluctuations in line voltage. It is often necessary to know the maximum watt demand, especially in the case of motor installations.

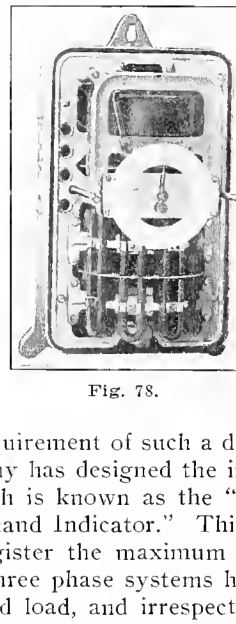


Fig. 78.

To fulfill the requirement of such a device the General Electric Company has designed the instrument shown in Fig. 78, which is known as the "Polyphase Maximum Watt Demand Indicator." This instrument will indicate and register the maximum watt demand on single, two or three phase systems having a balanced or an unbalanced load, and irrespective of the power factor and voltage fluctuations.

This type of indicator is simply a modification of the polyphase watthour meter, the ordinary retarding magnets being replaced by a greater number of very powerful permanent magnets arranged as shown, and with both electrical elements acting on the upper disc. The register as ordinarily furnished on watthour meters is replaced by a circular scale having two concentric pointers, one of which is connected to the disc shaft through a suitable train of gears; the other pointer being driven by the first pointer. As the load on the indicator causes the first pointer to deflect, the second pointer is carried to the maximum position reached by the first pointer, in which position it is held by a ratchet.

The upper, or "motor" dics is opposed and controlled by phosphor-bronze springs which confine the rotation of the disc to a definite number of revolutions. The torque acting on the disc is proportional to the power passing through the indicator, therefore

by using a control spring of many convolutions, the graduation of the scale can be made uniformly.

A curve showing the relation of the percentage of deflection to the time during which it takes the pointer to reach such deflection is shown in Fig. 79. It will be noticed that the curve rises very rapidly until the 90% position is reached, and that the time from 90% to 100% is relatively great; for this reason the indicators are usually rated by defining the time lag as

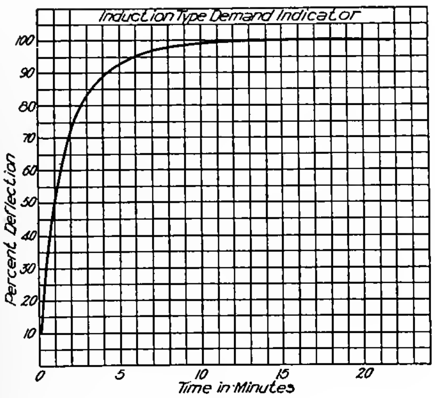


Fig. 79.

the interval of time taken to record 90% of any change in load. The time lag depends upon the torque of the electrical element and upon the retarding effort of the permanent magnets; by altering the effect of these two factors, a time lag from one to thirty minutes can be secured. By changing the position of the retarding magnets in an indicator having a definite rating, the time lag may be varied from 10% to 15%.

The polyphase maximum watthour demand indicator can be used on single phase circuits by connecting the potential coils in multiple and the current coils in series and dividing the scale deflection by two.

(To be continued.)

PRACTICE VS. THEORY AND THE RESULTING COMPOUND.

BY M. C. LORD.

The first consideration of a graduate from an engineering college after being filled with theory (unless father has money to burn) is a job where he can experiment with his theory and put it into practice. The job he gets depends on his training, personality and ability to sell his knowledge. If father has influence, these things may be modified somewhat; but assistance gained along these lines is often detrimental later. The man with the high technical training often conceives the idea that no position less than the general manager of a large corporation would be commensurate with his dignity and training and immediately proceeds to secure the position. But, alas! he finds the position held by a man who has secured his training in that greatest of universities—experience. After awakening to the fact that all the large corporations manage to make the wheels go around without his assistance, with no vacancies in the position he seeks, it is possible he may secure a position as a helper, to a lineman, for instance.

Now, his fellow-workmen will consider him an outsider. In accordance with his training, he hesitates to soil his hands, which makes the boys feel like handing it to him; which they generally do by giving him false information at every opportunity. It is with great difficulty, if he can swallow his pride and take it good-naturedly, that he at last gets at the facts of the case and gains such practical experience as will enable him to apply his theory to practical use.

The fault in most cases lies at the door of the institution from which he graduated. The professor perhaps is a graduate of a similar institution, and immediately began his career as a teacher, having had no practical experience in the application of the theory he is propounding.

Herein lies the reason why we find so many university graduates handling those well-known tools claimed as a heritage by the descendants of the Emerald Isle. For many of our university men are educated out of a job in the line of work for which they are preparing themselves, and the job is held by the man who is a graduate of that greatest of all universities which without an entrance examination we are all compelled to attend.

The practical man has not the opportunity to complete the high school in many cases, before entering into competition for an existence, and if he has chosen a trade, must serve his apprenticeship of four years, probably the first two of which were spent in carrying and cleaning tools, doing odd menial jobs, etc., about the shop; and then perhaps he is put to work on a job, which we will say is winding a machine. He will probably spoil the first one and waste some material, which is of course at the expense of his employer. He has acquired the experience to do a job of this particular kind, and as he has the ability to earn some money for his employer (who is human, and the law of preservation applies to business the same as life), the employer is loath to invest in any more experience for the employee, and of course keeps him on the same job if possible until his apprenticeship has been completed, when the employer has another boy ready to commence the task he will quit. The employer feels that the journeyman he has turned out is not competent to hold a journeyman's job in his shop, due to a lack of experience.

Now the young mechanic starts out for his university education, if he has the right kind of stuff in him, is ambitious and studies, gets a job and works his way to the top; while the university man works his way down to the plane of practicability, and (if he has the right kind of stuff in him), works his way up again.

Now the man wanted requires both practice and theory, and the time must come when they will be taught together as they should be, but such will not be the case until the professor has a practical knowledge of what he is teaching.

The words "may," "should," should be stricken out of lectures, and the words "it is done this way," substituted, but when you are telling a man how something is done and you do not know yourself, the above words are beautiful sidetracks upon which to shunt the too inquisitive student. If a student should visit all the technical bookstores in the city of San Francisco, I will venture the assertion that he will not find a book which will tell him how to connect one of the standard types of induction motors for different voltages and speeds.

RIGHT OF ELECTRIC COMPANIES TO CONDEMN LANDS.

BY LEO H. SUSMAN.[1]

To what extent private property may be taken by electric light and power companies when it is required to enable them to generate or trasmit electricity is an interesting problem. It is a question of great practical importance to a concern like the Pacific Gas and Electric Company, with its miles of transmission lines, flumes, and ditches extending over more than a score of counties.

The power of eminent domain, or as it is more popularly called, of condemnation, has been defined as the right of a sovereign state to appropriate private property to particular uses for the promotion of the general welfare. This power is inherent in and an attribute of every independent state of government by virtue of its sovereignty.

The constitutions of the various states of the union contain provisions relating to the power of eminent domain. They differ somewhat in the language employed, but practically all of them limit the right to such cases only as involve a public use. The constitution of California provides that "private property shall not be taken or damaged for public use without just compensation having been first made to, or paid into court for, the owner." (Article 1, Section 14.) No definition of public use is given in the California constitution, and it therefore becomes of prime importance to determine what is a public use in each particular instance. If the use in question be public, there can be no constitutional objection to a statute permitting the taking. But if the use be private, the taking is impliedly forbidden by the constitution of California.

The California law provides that the right of eminent domain may be exercised in behalf of the following public uses: "12. Canals, reservoirs, dams, ditches, flumes, aqueducts, and pipes and outlets, natural or otherwise, for supplying, storing, and discharging water for the operation of machinery for the purpose of generating and transmitting electricity for the supply of mines, quarries, railroads, tramways, mills, and factories with electric power; also for the applying of electricity to light or heat mines, quarries, mills, factories, incorporated cities and counties, villages, and towns; and also for furnishing electricity for lighting, heating, or power purposes to individuals or corporations, together with lands, buildings, and all other improvements in or upon which to erect, install, place, use, or operate machinery for the purpose of generating and transmitting electricity for any of the purposes above set forth. 13. Electric power lines, electric heat lines, and electric light, heat, and power lines." (Code of Civil Procedure, section 1238.)

The California legislature has declared by statute that private property may be condemned for certain designated uses. At first glance this may appear to be conclusive that property may be taken for any of such uses. But the fact that private property may be taken does not imply that it may be taken for private use. To illustrate: If one man own a city lot and another desire that lot for the purpose of erecting thereon and conducting an office building, the prospective builder can not force the owner of the lot to sell the land to him, as the erecting and conducting of an office building are essentially a private use, one in which the public has no concern. Suppose that the California legislature should enact a law providing that the erecting and conducting of an office building constitute a public use and that private property may be condemned therefor. Can the mere declaration by the legislature that a private use is a public use make it so? The California supreme court, in consonance with the views of many other authorities, has denied the California legislature this power, holding that the legislature can not, in the exercise of the power of eminent domain, permit the taking of private property for a purely private industry and that when it appears plain that property is sought to be taken for a purely private use, courts are not bound by the legislative declaration that a certain business is a public use. In a recent case Judge Gilbert, speaking for the United States circuit court of appeals, said: "The legislature can not by its enactments make that a public use which is essentially a private use, and the question whether the use is public in its nature is a judicial question to be determined by the courts. But it is the general rule that where it is uncertain and doubtful whether the use to which the property is proposed to be devoted is of a public or a private character, the legislative determination of the question is of persuasive force, and the courts will not undertake to disturb the same." (Walker vs. Shasta Power Company, 160 Fed. Rep. 856.)

The mere fact that the public is interested incidentally in the operation of a business and that the use may benefit the public in some collateral way does not make it a public use. In a recent case, decided by the supreme court of Minnesota, it was held that a use is not public unless the person or corporation seeking to condemn property can be compelled, under proper police regulations, to supply the public with the service or use for which the property is sought to be acquired. In this case the plaintiff company sought to condemn lands for the construction of canals and for the creation of a water-power plant that would generate and distribute electricity for light, heat, and power purposes and supply water power. The court held that while the generation of electric power for sale to the general public on equal terms is a public enterprise and the property so used is devoted to a public use, the creation of a water-power plant to supply water power from its wheels is not for a public use for the reason that only a few persons can purchase water power from the wheels. The court declared: "Water power from the wheels must be used at the wheels, and the actual result necessarily is that a very few individuals will use that power for manufacturing purposes to the exclusion of all other persons. The effect is the creation of a power plant to create water power to sell to a few manufacturers for use in their private business. Under such conditions, the willingness of the power company to sell power from the wheels to the general public has only a theoretical value."

The difficulty in determining whether or not a given electric power or lighting business is for a public use is not so much over the legal principles involved

[1]Pacific Gas and Electric Co.

as over the proper application of those principles to the facts of each particular case.

In some states the generation and sale of electricity under certain circumstances have been held not to be a public use. But in the majority of jurisdictions where the question has arisen the generation and sale of electricity have been held to be a public use wherever the company proposing to exercise the power of eminent domain must serve the public fairly and without discrimination.

In the case of Rockingham County Light and Power Company versus Hobbs (72 N. H. 531) the supreme court of New Hampshire said: "The knowledge recently acquired concerning electricity has made it possible to divide power into any desired portions and freely to transmit the same to almost any point for use. This has created a demand for power, which, though not so general as the demand for water, is nevertheless of a public character. Like water, electricity exists in nature in some form or state, and becomes useful as an agency of man's industry only when collected and controlled. It requires a large capital to collect, store, and distribute it for general use. The cost depends largely upon the location of the power plant. A water power or a location upon tide water reduces the cost materially. It may happen that the business can not be inaugurated without the aid of the power of eminent domain for the acquisition of necessary land or rights in land. All these considerations tend to show that the use of land for collecting, storing, and distributing electricity for the purpose of supplying power and heat to all who may desire it is a public use, similar in character to the use of land for collecting, storing, and distributing water for public needs, a use that is so manifestly public that it has been seldom questioned and never denied."

In some instances the electric company, seeking to condemn, has been incorporated for the purpose of generating and selling electricity to the public generally, and also for private purposes. The right to exercise the power of eminent domain has been denied to such companies where they sought to condemn indiscriminately for both public and private uses. But the fact that such a company was, by its articles of incorporation, authorized to engage in a private enterprise as well as to serve the public, will not prevent it from exercising the power of eminent domain for the public use. In determining whether an electric company is exercising a public use the court is not limited solely by the description of the objects and purposes set forth in the articles of incorporation, but may consider evidence outside of such articles, showing the actual purpose in view.

In the case already mentioned of Walker against the Shasta Power Company the United States circuit court of appeals upheld the validity of the subdivision of section 1238 of the California code of civil procedure relating to the condemnation of ditches for supplying water to hydroelectric machinery. Although the question has not been directly passed upon by the supreme court of California, this decision of the United States circuit court of appeals would be of persuasive force. Both reason and authority being in favor of the validity of this statute it may be taken to be the law in California that a corporation, such as the Pacific Gas and Electric Company, generating and selling electricity to municipalities and their inhabitants for light, for the operation of railways, and for general commercial enterprises, uniformly and without discrimination, is engaged in a public use for which it may exercise the power of eminent domain.

OPERATING COSTS OF THE STOLL TRACKLESS SYSTEM.

The Stoll system is in actual operation at Vienna in connection with the municipal tramways (in the Potzleinsdorf-Salmannsdorf district), at Weidling near Vienna; at Gmund, Lower Austria; at Budweis, Bohemia (opened in November, 1908), and is being installed at Pressburg, Hungary. The last named will have 5.8 kilometers (3.6 miles) of line with four wires, six passenger cars, and one goods wagon, the whole to cost 300,000 crowns (about $60,000).

According to the figures which have been furnished, the working costs of running vehicles on this system are reasonable. The following are given as being the costs in Vienna of running a car 75 miles daily:

Current (1 cent per kilowatt-hour)	$0.40	to	$0.60
Tires (total load 4.2 tons)	1.50	to	2.00
Wages (driver only, also for tickets)	1.60	to	1.80
Garage	.30	to	.40
Taxes, management, insurance	.80	to	1.20
Repairs, painting, renewals of cars, and conductors	.60	to	.80
Total running costs	$5.20	to	$6.80

This figures out 7 to 9 cents per mile. The line is 2.2 kilometers (1 1-3 miles) long. It passes through narrow streets and around narrow and sharp corners on a continuous steep gradient up and down, the steepest being 10 per cent for a long distance. In order to meet the extraordinary requirements of an intense summer and Sunday traffic, two separate aerial lines are provided to let the cars pass without stopping. The positive pole of each conduit is connected with the conduits of the city tramways, and the negative pole with their rails. At both termini loops are arranged, so that the cars are continually running round. Four elegantly fitted cars, each for 24 passengers, are doing service on this line.

The Stoll trackless trolley system line at Weidling, near Vienna, is 2.3 miles long and has a tortuous, hilly road, with a gradient of 7 per cent. Three cars, with 21 seats each, were purchased with the idea of conveying 120,000 passengers per annum, whereas 132,000 passengers were carried during four months only, hence two new cars have been ordered. The three cars are doing excellent work, notwithstanding the heavy traffic, 60 to 100 miles being run daily from 5:30 a. m. to midnight; on Sundays 2700 passengers are carried, at fares a little over 4 cents. This can only be done by nonstop runs; the meeting of cars and interchanging of trolley cables needs only 10 seconds and can be done at any point on the way. The mails are carried in a box under the car.

The Stoll line at Gmund is under municipal control and is running on a passenger and postal service between the town of Gmund and the railway station. This line was originally estimated to carry 24,000 passengers a year, but actually carried during the first six months of the service 44,305 passengers.

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Pacific Coast Institute Meeting

In accordance with a recent decision whereby the scope of the American Institute of Electrical Engineers may be so extended that the organization may exert a proper national influence, and its individual members throughout the country receive greater benefits, a meeting is to be held on the Pacific Coast early in May. San Francisco has been selected as an accessible point and the time has been fixed as May 5th, 6th and 7th. This meeting is to be held under the auspices of the High Tension Committee, assisted by a local committee, consisting of Messrs. Geo. R. Murphy, S. G. McMeen, J. C. Hays, and A. M. Hunt. Papers to be presented include "The Developed High-Tension Network of a General Power System," by Mr. P. M. Downing; "Hydro-Electric Developments and Irrigation," by Mr. John Coffey Hays; "Emergency Generating Stations for Service in Connection with Hydro-Electric Transmission Plants Under Pacific Coast Conditions," by Mr. A. M. Hunt; "Observation of Harmonics in Current and Voltage Wave Shapes of Transformers," by Mr. J. J. Frank; "Parallel Operation of Three-Phase Generators with Interconnected Neutral," by Mr. G. I. Rhodes; "Transmission Line Crossngs of Railroad Rights of Way," by Mr. A. H. Babcock. It is expected that in addition to a number of the national officers from the East, including President L. B. Stillwell, there will be a large attendance from the northwest sections and Southern California. Arrangements have been made for trips of inspection over the lines of the Pacific Gas & Electric Company and the power plant of the Great Western Power Company for Eastern visitors during the week following the meeting, and every courtesy in visiting the plants adjacent to San Francisco Bay has been extended by the power companies. As this is the first national meeting to be held on the Coast, we hope that every one of the Pacific Coast members will do their best to make it a success.

Interurban Electric Traction

The electric railway, together with electric power and the telephone, is an able assistant in fostering that "back to the country" migration urged by reformers. Given these city comforts, country life is attractive to all but the most confirmed apartment-house denizen. A development of less than a score of years, the interurban electric road has already become well-nigh indispensible.

The Eastern States have been so grid-ironed with these links of steel and copper that it will soon be possible to travel for nearly one thousand miles from Wisconsin to New York entirely in electric cars. Night travel has been facilitated by sleeping-cars even more convenient than those on the steam roads. Such long-distance travel, however, is but incidental to electric traction's prime province in giving rapid and convenient access from outlying farms and villages and to city advantages.

As for the Pacific Slope we find excellent systems of electric railroads in the Inland Empire, on Puget Sound, surrounding Portland, around San Francisco Bay, throughout California's great central valleys and about Los Angeles. In some places they parallel existing steam roads, while in others they tap a virgin country whose wealth of raw products give a profitable freight business, in addition to passenger traffic.

Wherever they go they bring new settlers to the ranch lands and new blood to the towns. They populate the country more rapidly than do the jack rabbits they displace.

As yet they have seldom proven serious competitors to the steam lines, which have usually profited by the new business created in their territory by the electric road. Local competition is being met either by electrifying steam lines or by running gasoline motor cars. Aside from the frequency of service that is possible with electric cars one of the main advantages of such service is the greater speed that can be safely made with numerous intermediate stops. The fare is generally lower than that of a steam line and the convenience and comfort of the passenger greater. Notwithstanding these advantages it is a brave group of men possessed with the necessary courage to finance a new project in a country which at best may be but partly settled. All credit is therefore due the backers of the Northern Electric Railway, a description of which occupies the major portion of this issue.

Three Cent Fares

Telegraphic reports of profit in the first month's operation of the Cleveland, Ohio, street railway system on the basis of a three-cent fare are being given prominence in the daily press. Some of the more radical of these papers even suggest that a like rate be enforced in other cities throughout the country. Some day, perhaps, a history of the traction experiments of Cleveland may prove the rule and guide to those interested in the regulation of public transportation, but until these experiments have been crystallized into profitable practice they seem but poor models upon which to pattern present legislation. The much-heralded innovations of Tom Johnson have already been discredited by the test of actual use and there still remains a possibility that the methods substituted may not be quite as successful as anticipated.

Under the new system, which is to be tried out for eight months, the initial rate of fare is three cents, with one-cent charge for a transfer. If the rider has not three cents in change, or a cardboard ticket which may be bought at the rate of five for fifteen cents, he is charged five cents for his ride, thus lessening the conductor's work. As a result of this preliminary trial the final fare will be increased or decreased so as to insure a six per cent dividend to stockholders.

It is too soon to predicate prophecy upon the first month's showing, but aside from the controlling feature of legitimate dividends to investors there are two bearing factors which should not be overlooked. One is the fallacy of fixing a permanent charge on the basis of temporary and shifting costs of operation; the other, and perhaps the more important, is a consideration of the satisfaction and convenience of patrons.

Economic writers tell us that the high cost of living is affecting not only individuals but also corporations. A street-car ride is one of the few public necessities which has not kept pace with the general upward trend of prices. Except for copper all the thousand and one supplies necessary in the construction and operation of an electric railway now cost more than they did five years ago. Rolling equipment and roadbed are not exempt from wear, and each year finds a greater depreciation than the former. Wages are also soaring. In view of climbing costs and reducing revenues, capital may hesitate to assist what appears to be a hazardous undertaking. Such hesitancy can but retard the good work which is being done by electric traction companies in developing outlying real estate.

As a matter of fact, all signs show that the nickel fare, which has come into such universal use as to be almost standard, will be raised rather than lowered. When we consider the convenience and the time saved by the electric car the present charge seems low enough. Many of the Eastern cities, particularly in New England, have already been forced to increase their fare to six cents, this action having the endorsement of legal decision. The road between Seattle and Tacoma has also increased its rate and it is not unlikely that other companies will soon do the same.

With respect to the public's opinion of Cleveland's street-car system we cannot do better than to quote from an article in a recent number of the Electric Traction Weekly of Chicago, which explains that the company, with the sanction of the city, refuses to make change for a nickel, and further that it will not issue a transfer unless an additional cent is tendered with the nickel. On cross-town lines the cash passenger must buy a transfer, while one presenting a transfer can transfer to another line free of charge.

> Under the Taylor plan as at present in force in Cleveland, you can pay anywhere from three cents to twelve cents to reach your destination. Small wonder that the people are already showing dissatisfaction, when it is considered that the proposition made by the Cleveland Electric Railway two years ago offered a rate of seven tickets for twenty-five cents and free universal transfers, over the entire system.
>
> One of three ladies who had boarded a car dropped a dime into the fare box to pay for three fares at three cents per, and she tendered two cents more and demanded three transfers at one cent per. The conductor informed her that without the change the fares would be five cents per and the transfers one cent each. The arguments those three indignant ladies put up and the threats of the conductor to eject them, tied up a line for ten minutes. The authorities decided that the conductor was in the wrong in this case.

Another woman tendered fifty cents with the expectation of getting a ride for three cents and a transfer for one cent, but found that she must first pay five cents for her fare, receiving forty-five cents in change and then pay five cents more for a transfer, receiving four in change. These examples indicate the vexatious confusion attending what should be a simple transaction.

PERSONALS.

W. G. Kerckhoff, of Los Angeles, was a visitor in San Francisco last week.

J. C. Kirkpatrick, president of the National Pole Co., is visiting San Francisco.

W. M. Carpenter, president of the American Cross-Arm Co., is in San Francisco.

F. B. Gleason, manager of the San Francisco offices of the Western Electric Co., has returned from the East.

R. S. Chapman, engineer for H. M. Byllesby & Co., recently returned to San Francisco from a trip to Los Angeles.

M. M. O'Shaughnessy is in San Diego superintending the construction of a large dam for increasing the city's water supply.

W. S. Heger, Pacific Coast manager of the Allis-Chalmers Company, has returned to his San Francisco office, after a trip to the factory in Milwaukee, Wis.

W. P. Hammon, who is at the head of the California-Nevada Power Company and of the Truckee River General Electric Company, has gone East on business.

Prof. M. E. Cooley, dean of the Engineering Department of the University of Michigan, is one of a party of college professors who are making a tour of the Pacific Coast.

Frank H. Ray, who is interested in the Rogue River Electric Light & Power Company and its subsidiary corporations in Southern Oregon, was a San Francisco visitor during the past week.

Harry C. Rice, vice-president of the General Incandescent Lamp Co., of Cleveland, who is making a tour of the Coast, arrived in San Francisco April 19th. He will visit Southern California next.

Harry Brownlee, Berkeley manager of the Pacific States Telephone & Telegraph Company, has been advanced to the managership of the San Jose district and has been succeeded by Herbert Cheek.

W. E. Adams, who is connected with the management of the Stockton Gas & Electric Company, arrived from Stockton last week and reported an excellent outlook for business in the San Joaquin Valley.

H. A. Lardner, manager of the San Francisco office of the J. G. White & Co., who has been confined to a local hospital with typhoid fever for several weeks, is convalescent and will be out in a few days.

F. W. Gray, mechanical engineer for the J. G. White & Co., and Albert S. Crane, the chief hydraulic engineer for the company, have arrived from New York and are visiting the company's San Francisco branch.

C. E. Sloan, of Spalding, Sloan & Robson, engineers, has returned from a trip to Newman, Cal., where he has been supervising a waterworks contract. E. B. Spalding, of the same firm, will remain at Newman for some time on similar business.

Beach Thompson, promoter of the Stanislaus Electric Power Company, recently visited New York City to confer with Patrick Calhoun and officers of the United Railways Investment Company of New Jersey regarding the plans for the further development of the plant near Sonora, Cal.

C. E. Groesbeck, vice-president of H. M. Byllesby & Co., of Chicago, spent several days in San Francisco and departed during the past week for Portland, Ore., where offices are now maintained in connection with the operation of a number of Pacific Coast electric power and gas plants.

Paul Shoup, formerly assistant general passenger agent of the Southern Pacific Company, has been appointed assistant general manager in charge of the electric lines. Shoup's new position gives him charge of all of the electric lines owned or controlled by the Southern Pacific Company, including the lines in Los Angeles, the Peninsular electric lines and the Alameda County lines upon their completion.

Frank R. Wheeler, Pacific Coast Manager of the C. H. Wheeler Mfg. Co., has returned from a trip to Puget Sound and British Columbia in the interest of his Company. He reports recent sales of Condensing apparatus to the Hammond Lumber Co., Spreckels Sugar Co., Pacific Fruit Express, Union Ice Co., L. A. Gas & Electric Co., and the Kleeb Lumber Co. U. S. Mint, San Francisco.

PACIFIC COAST ELECTRICAL EXPOSITION.

At a meeting of the Pacific Coast Electrical Exposition exhibitors held Friday, April 15th, it was unanimously decided to postpone the electric show until some time in September, as the proposed Auditorium was found to be too small to accommodate the exhibits. Mr. S. Naphtaly, of the City Electric, and Mr. Geo. C. Holberton, of the Pacific Gas & Electric Company, were selected as an advisory committee to act with the board. Vacancies caused by the resignation of E. M. Scribner and R. B. Elder have not as yet been filled.

Too much credit cannot be given to Mr. W. W. Briggs for his persistent and earnest work in behalf of this electrical show. And now that the General Electric Company, through its representative, Mr. T. E. Bibbins, has declared their intention to participate, the exhibitors show considerable enthusiasm, and are determined to give one of the finest electrical exhibits ever held west of Chicago. The postponement will give ample time for preparation and we hope that every Eastern manufacturer of electrical goods will realize the importance of being represented.

PORTLAND SECTION A. I. E. E.

At a meeting of the Portland Section A. I. E. E., held on April 19th, W. M. Hoen read a paper on "The Electrical Installation of a Modern Quartz Mill." Mr. Cary T. Hutchinson's paper on "The Electric System of the Great Northern Railway at Cascade Tunnel" was abstracted by Mr. Paul Lebenbaum. Mr. Lebenbaum also presented a short paper on "Heavy Traction Work" of his own experience.

SAN FRANCISCO SECTION A. I. E. E.

A meeting of the San Francisco Section A. I. E. E. will be held in the Home Telephone Company's building on April 29, 1910. A paper on the "Watthour Meter" will be read by A. G. Jones and Wm. M. Shepard.

TRADE NOTES.

Wilbur H. Jackson, 404 Sutter street, has been appointed agent for the Hoffman-Corr Manufacturing Company and carries a stock of their cotton waste and oakum.

The San Diego Consolidated Gas & Electric Company has purchased one General Electric 3-phase, 60-cycle, 32-pole, 185-kw. (250 h.p.), 225-r.p.m., 2300-v. synchronous motor, with a Mortisseur winding, to be used for driving an Ingersoll-Rand air compressor.

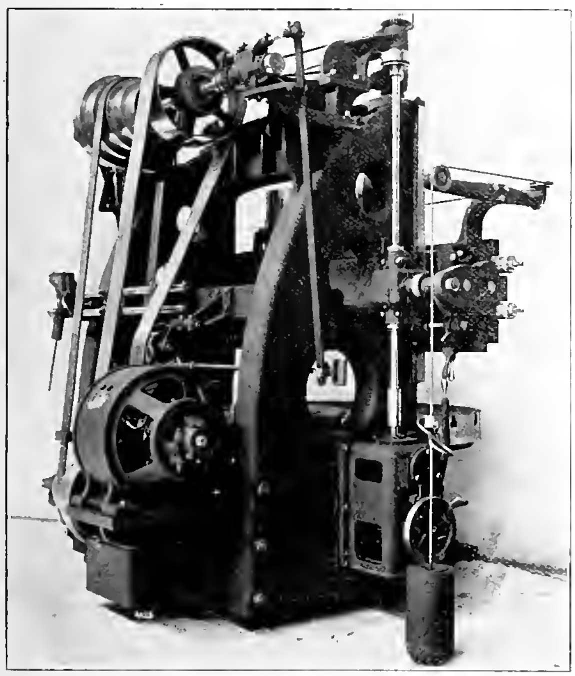
The General Electric Company has sold the following equipment to the Yuba Construction Company of Marysville, for use in a gold dredge: A 300-h. p. variable speed 440-volt main drive motor; 35-h. p. winch motor; 150-h. p. high-pressure pump motor; 25-h. p. auxiliary pump motor; 60-h. p. 4,000-v. primary—460-v. secondary transformers.

INDUSTRIAL

A NEW TYPE OF LARGE BORING MILL.

The 60-in. motor-driven boring mill shown in the accompanying illustration, is one of a new line of machine tools which embody a number of valuable improvements in design and operation. This 60-in. mill has a table 62 in. in diameter and takes work 46 in. high under the cross-rail. Its design has been figured for ample strength to withstand the heaviest cuts with high-speed steels, and has a massive angular bearing which makes the table self-centering under any condition of load or work.

The cross-rail is box-shaped, of massive proportions, and is raised by power independently of the table drive. The heads carrying the tool-holders are entirely independent in their movements, both in the direction and amount of their feed. They can be set for any angles and have a vertical or



New Type of Boring Mill.

angular travel of 30 in. Both heads can be brought to the center of the cross-rail, for boxing. The middle point is accurately marked by a positive stop.

The power rapid reverse feature is furnished regularly on all 60-in. mills. This device is entirely separate from the regular feeding mechanism, and is driven at constant speed, direct from the countershaft by silent chain. By means of frictions located at the upper ends of the vertical feed shafts, a rapid motion is communicated by power to the feeding mechanism. These frictions can be engaged instantly at any time by simply pulling the rapid traverse lever, located in a convenient position above the feed box. Pulling this lever automatically disengages the regular feed, and reverses the travel of the tool at a speed of 9½ ft. per minute horizontally, and 6 ft. per minute vertically and in angular directions. It is impossible for accidents to occur with this device, and no mental effort is required on the part of the operator, as there is but one direction in which to pull the lever, which always returns the tool over the surface on which it has taken the cut.

The power rapid traverse is one of the greatest labor-saving and production-increasing devices ever put on a boring mill. It entirely eliminates the laborious work of moving the heads by a crank-handle or a wheel.

The safety shear-pin device placed on the rear of each end of the cross-rail, prevents injury to the feed mechanism in case the heads are accidentally run together. A coupling introduced into the vertical-feed-shaft transmits its motion through a small pin, which is arranged to be sheared off in case any abnormal stress occurs in the feed mechanism. Additional pins are furnished, or in case of emergency, a wire nail may be used equally well.

This 60-in. boring mill is driven by a 10 h.p., 1180 r.p.m., Westinghouse constant-speed type S direct-current motor, belted through countershaft and cone-pulleys to the driving shaft of the mill. A belt-shifter makes the changes from step to step of the cone-pulleys easily and quickly, and without injury to the belt. The friction clutch in the cone-pulley countershaft permits the mill to be stopped and started without interfering with the motor.

The new line of large boring mills, described and illustrated in the foregoing, and which includes machines built in 42, 48, 54, 60 and 72-in. sizes, is manufactured by the Colburn Machine Tool Company, Franklin, Pa. These machines may be equipped with constant or adjustable-speed Westinghouse motors, if desired.

NATIONAL PUBLICITY FOR BENJAMIN ELECTRIC MANUFACTURING COMPANY.

The Benjamin Electric Manufacturing Company of Chicago is carrying on a campaign of national publicity for the Benjamin plug cluster in many of the popular magazines, thus supplementing its advertisements in the trade journals. The purpose is to reach the ultimate user and create a demand for a socket which doubles the fixture capacity.

NEW CATALOGUES.

The Roller-Smith Company, 203 Broadway, New York City, have issued an attractive catalogue on its electric automobile type ammeters and voltmeters. Their distinguishing features are resilient mounting and zero adjustment.

The Western Electric Company has recently issued its bulletin No. 5132-1, describing its type EC belt-driven Hawthorn generators. A complete description of the construction and operation of its generators is given, with illustrations of the different types. Considerable space is given to a description of the individual parts of these generators. Copy of the bulletin will be sent upon request.

A subject apropos of the season is taken up in the General Electric Company's Bulletin No. 4719, describing its fan motors and small power motors for the season of 1910. This publication illustrates and describes fans suitable for use in the home, office, or public building, for installation on a desk, table, wall, floor or ceiling, and for use in telephone booths. It lists also fans for ventilating purposes, and illustrates small power motors for both domestic and commercial use.

In Bulletin No. 4716, published by the General Electric Company, are described several types of prepayment watthour meters, which form a practical solution of the problem of producing a satisfactory prepayment meter having a minimum number of complicated parts, and sufficiently strong to withstand the rough treatment incident to transportation and commercial use. These meters are arranged for use with either a separate or combined prepayment device. They are made for two and three-wire service, and 100 to 120, or 200 to 240 volts, direct or alternating current. This publication contains dimension of the meters, and diagrams of connection.

NEWS NOTES

INCORPORATIONS.

BORING, ORE.—The Boring Mutual Telephone Company has been incorporated for $5,000, by J. W. Roots et al.

MACLEAY, ORE.—The Lewisburg Mutual Telephone Company has been incorporated for $1,173, by Ernest Bowen et al.

BOYDS, WASH.—The Kettle River Power & Irrigation Company has been incorporated for $6,000, by Grant A. Stewart et al.

MILES CITY, MONT.—The Miles City Automatic Telephone Company has been incorporated for $300,000, by H. Hauson et al.

MOUNT ANGEL, ORE.—The Mount Angel Telephone Company has been incorporated, by C. R. Hougham, H. Klinger and G. D. Ebner, with a capital stock of $5,000.

SACRAMENTO, CAL.—Elmhurst Street Railway Company has been incorporated, with a capital of $100,000, by H. J. Goethe, H. A. McClelland, C. M. Goethe and G. P. Beere.

SAN FRANCISCO, CAL.—The Sierra Nevada Power and Irrigation Company has been incorporated, with a capital of $200,000, by J. F. Sheehan Jr., J. J. Dailey and Isaac Kermel.

SPOKANE, WASH.—The Citizens' Electric and Manufacturing Company has been incorporated, by M. J. Gardner, J. H. Peet, A. E. Anderson and others, with a capital stock of $50,000.

STEWART, B. C.—The Stewart-Portland Canal Power, Light & Water Company, Ltd., has been incorporated with a capital stock of $250,000 to supply this place and others with gas, power and water.

FINANCIAL.

ST. HELENS, ORE.—St. Helens has voted for a $50,000 bond issue for the construction of a municipal water system.

FALLS CITY, ORE.—An election decided in favor of a $20,000 bond issne for the construction of a water system, the water to be taken from a spring 2½ miles south of the town, and to be brought in by gravity.

PORTLAND, ORE.—One million dollars' worth of water bonds, running 25 years, drawing interest at the rate of 4 per cent, payable semi-annually, have been ordered advertised for sale by the City Auditor, A. L. Barbur, the proceeds to furnish money for the construction of a second pipe-line to Bull Run River.

SAN FRANCISCO, CAL.—Following is a statement of the earnings and expenses of the Pacific Gas & Electric Company, including the figures of all of its subsidiary corporations for 1909: Gross revenue, $13,650,075.28; deduct revenne in suspended (S. F. rate cases), $317,574.25; gross revenue, $13,332,501.03. Operating expense, maintenance, tax and reserves for uncollectable accounts, casualties, etc., $7,531,575.89; net revenue, $5,800,925.14. Interest, $2,988,-521.70; balance, $2,812,403.44. Deductions—Accrned dividends on preferred stock, $600,000.00; sinking funds, $667,-209.56; am. of bd. dist. and exp., $42,236.95; total, $1,309,-446.51. Balance, $1,502,956.93. The gross revenue of the Pacific Gas and Electric Company for the year 1908 was $12,853,817. The net income available for interest on the debenture mortgage bonds was $2,052,329.64. After deducting from this amount $240,000 as the annual interest on the entire authorized issue of debenture mortgage bonds the balance December 31, 1908, was $1,812,329.64. On March 31, 1909, the company's entire outstanding bonded debt in the hands of the public was $56,182,000. This was made up of: Divisional and underlying bonds, $43,378,000; P. G. & E. Co. general and collateral trust 5-per cent bonds, $9,153,000, and debenture mortgage 6-per cent sinking fund 30-year gold bonds, $3,651,000. The debenture mortgage bonds precede the following securities of the P. G. & E. Co.: $9,979,000 6-per cent cumulative preferred stock; $12,566,000 common stock outstanding March 31, 1909, of which the market value at that time was $14,500,000. The balance of $1,502,956, December 31, 1909, would show abont 10 per cent on $15,000,000.

TRANSMISSION.

BUHL, IDAHO.—The Clear Lake Orchard Company will install a power plant of sufficient capacity to furnish heat and power for the Twin Falls and the North Side tracts.

JUNEAU, ALASKA.—Otto Lonstorf, general manager of the Lon De Van Mining Company, announces that a power plant is soon to be installed at the mines on George's Inlet.

MONROE, WASH.—The Snoqualmie Power Company will shortly begin work on the erection of a transformer station in Park place, where its wires cross the connty road.

KOOSKIA, IDAHO.—It is reported that a Chicago company, headed by a Mr. Day, of the Marshall-Fields Company, will in the near future install a power plant on the Middle Fork.

CHEHALIS, WASH.—The Twin City Light & Traction Company let the contract for erecting a $75,000 powerhouse on its mill site in the north end of town to the Coal Creek Lumber Company.

PORT ANGELES, WASH.—The power and light franchise granted to Thos. T. Aldwell has been assigned to the Olympic Power & Electric Company, which will begin work immediately on the development of power on the Elwha River.

DAWSON, ALASKA.—The North Fork Power Company will begin within a few days to haul supplies from Dawson to the North Fork of the Klondike, where extensive development will commence. Seven and one-half miles of ditch will be built. Chas. Bolye, resident manager of the Canadian Klondike Company, is in charge of the work.

LEWISTON, IDAHO.—Local capitalists interested in the concern announce that the Lewiston-Clarkston Improvement Company, which recently passed into the control of Spencer-Trask of New York, has been bonded for $800,000 and that a large amount of money will be expended in developing a 50,000-hp. plant on the Grand Ronde River.

SEATTLE, WASH.—As a formal step in the plan of the Stone & Webster interests to develop the White River hydroelectric power enterprise, a meeting of stockholders of the Pacific Coast Power Company will be held in Seattle to increase the capital stock from $7,000,000 to $10,500,000. According to attorneys for the company, the meeting will be the last step necessary in placing the affairs of the corporation in shape to develop the White River power project, by which the waters of the river, impounded in Lake Tapps, will be harnessed and 30,000 electric hp. developed for electric and interurban railroad systems and manufacturing purposes in Seattle, Tacoma, Bellingham and Everett. The initial development at Lake Tapps will require an expenditure of abont $2,250,000 and the work will be done by the Stone & Webster Engineering Corporation.

TRANSPORTATION.

LONG BEACH, CAL.—It has been stated that the Pacific Electric would build its Seventh-street extension in the early summer.

ALBANY, ORE.—The survey work has been started for the Albany and Interurban Railway, to run from this place to Sweet Home.

WALLA WALLA, WASH.—A survey is being made by the Byllesby interests for an electric line between this place and Pendleton, Ore.

KALISPELL, MONT.—A franchise has been granted to the Whitefish & Polson Electric Railway Company for its railway system here.

WHITEFISH, MONT.—This place has granted a franchise to the Whitefish-Polson Electric Railway to construct its road through town.

CITY OF MEXICO, MEX.—A street-car line is being planned to connect Merida with the ruins of Uxmal. This will be a great convenience to tourists.

SNOHOMISH, WASH.—The City Council has granted a 25-year franchise to the Seattle, Snohomish & Everett Railway Company to build lines within the city.

PORTLAND, ORE.—Geo. D. French, president of the Spokane, Portland and Seattle Railroad, states that equipment and improvements for the road will entail an expenditure of $1,500,000.

SALT LAKE CITY, UTAH.—Le Grand Young has received a franchise from the Board of County Commissioners for his proposed electric railroad to connect the Emigration Canyon road with Holliday.

STOCKTON, CAL.—It is probable that the Central California Traction Company, now operating an electric line to Lodi and building to Sacramento, will also construct a line to Lockeford, which is northeast of Stockton about 12 miles.

EUGENE, ORE.—It is announced that the Portland, Eugene and Eastern Railway Company has secured financial backing for its proposed system of electric roads to be constructed in this vicinity. A. Welch is general manager of the company.

PORTLAND, ORE.—A contract has been let to the Porter Bros. for the construction of the Cornelius Gap tunnel of the United Railways, and machinery is now being rushed to the scene of operations, with a view to having the big underground passage completed before the end of summer.

EVERETT, WASH.—A $5,000,000 mortgage in favor of the Chicago Title & Trust Company, and signed by O. E. Crossman, president, and Charles H. Barron, for the Everett-Tacoma Railway Company, which proposes to build an electric road to Tacoma via Snohomish, Monroe, Tolt, Renton, Kent and Puyallup.

RIVERSIDE, CAL.—Application has been made to the Supervisors for a franchise for a trolley line for connecting the towns of Moreno, Lakeview, San Jacinto, Hemet and Florida and extending up to foot of grade in San Jacinto Mountains. The proposed road is 25 miles long. J. B. Jackson, who has interests in the San Joaquin Valley, made the application. The board favors the proposition.

MODESTO, CAL.—The Modesto interurban terminal will be on South Eleventh street, between D and F. The company has purchased the half-block on Eleventh street, across from the Kewin stables, taking in the Harris machine shop, and the half-block south, between D and E streets. It is understood that the company will build a passenger depot on the site, together with freight sheds and other buildings to accommodate the traffic. It is expected that announcement of the running schedule of the new line will be made within the next few weeks.

OAKLAND, CAL.—Grading work for the extension of the tracks of the Southern Pacific from the present terminus in Melrose, along the foothills eastward to Stonehurst, where a junction will be made with track already laid, thereby completing a loop suburban system which will extend almost completely around the newly annexed districts of Oakland, has been commenced on the north side of Melrose by Peter Hare, a Hayward contractor. The Southern Pacific already has a spur track running from its main line which taps the southern side of the annexed district, to Stonehurst Station on East Fourteenth street. The grading work commenced will be for the extension of the tracks which now reach Melrose Station. The tracks will extend across East Fourteenth street toward the foothills and then turn eastward as far as Stonehurst. It is probable that the loop system may also be extended as far eastward as San Leandro, the running schedule being arranged so that only several trains a day shall run through that town, while the majority of them shall go over the other loop system which goes through Stonehurst. The preliminary grading work commenced is in the vicinity of the Scenic or Foothill boulevard.

ALAMEDA, CAL.—Mayor W. H. Noy has received word from the Southern Pacific Company that its new Alameda electric train service would not be ready for operation before September 1st. The company has ordered 125 standard electric cars for its Alameda County lines. Of this number 40 are motor cars, 25 are combination motor cars and baggage coaches, and 60 are trailers. The cars are 58 feet long and are being built in the shops of the American Car and Foundry Company, at St. Charles, Mo. The Baldwin Locomotive Works is furnishing the trucks, and the motors will be supplied by the General Electric Company. The Southern Pacific track-layers have commenced work on the new cross line, which is to run between Alameda and Oakland and be one of the features of the new electric service of the company. This line is being built upon Eighth street in West Alameda, and will connect on the north with the present line across the Alameda marsh. A connecting link will be built near the water front to straighten the line to the Alice-street bridge. Electric trains will then be able to run direct into the heart of Oakland, stopping at the present Oakland narrow-gauge terminus and Fourteenth and Franklin streets, or possibly continuing out into Berkeley over the projected extension. This line will make the Southern Pacific an active competitor of the Oakland Traction Company for the Alameda-Oakland service. A 5-cent fare will be charged and transfers from the regular Alameda loop system will be given without additional charge.

ILLUMINATION.

EL PASO, TEX.—Six or seven miles of mains will be laid soon by the El Paso Gas & Electric Company.

MEDFORD, ORE.—The Council passed an ordinance granting to J. R. Anderson the right to lay gas pipes and conduits for a period of 35 years in the public streets and alleys of the city of Medford.

SALINAS, CAL.—Sealed bids will be received by the Clerk of the Board of Supervisors up to 2 p. m. May 4, 1910, for the construction of an electric light system at the County Hospital of the county of Monterey, Cal.

KINGMAN, ARIZ.—The capacity of the electric power plant at this place of the Tracy Engineering Company in the Central building, will be increased by the installation of more machinery at the cost of about $30,000.

CHICO, CAL.—The announcement is made that the Sacramento Valley Power Company will be actually competing for business in this city by April 20th. The transformers are now being installed, and the line between Redding and Chico has been completed. Nearly 1,000 poles have been planted in Chico, and most of the wires have been strung.

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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JOURNAL OF ELECTRICITY

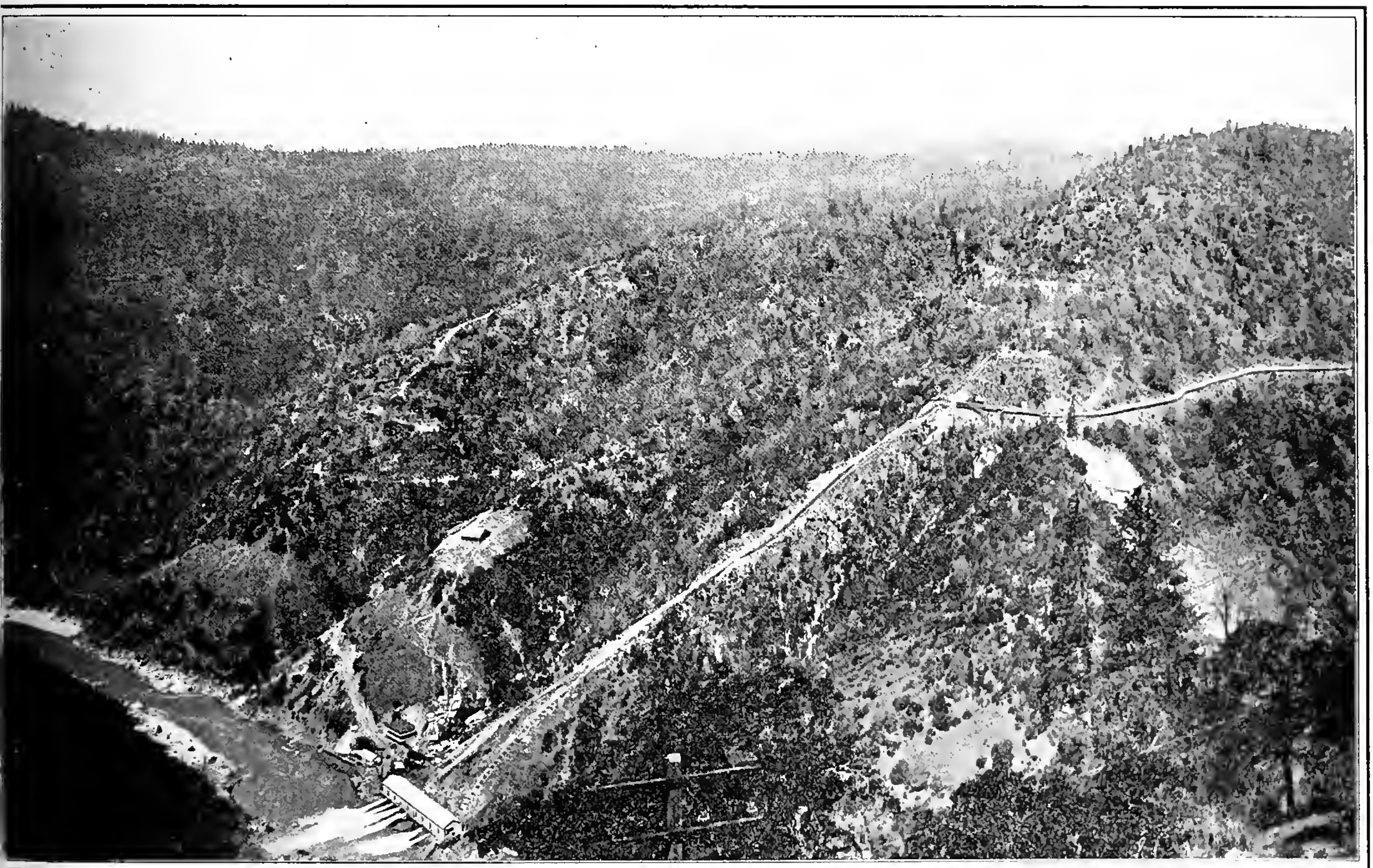
POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXIV — SAN FRANCISCO, APRIL 30, 1910. — NUMBER 18

THE STORY OF COLGATE AND YUBA POWER PLANTS

BY ARCHIE RICE



The Colgate Plant on the Yuba River.

Archie Rice

Nowhere in the world, probably, is a huge, modern, hydro-electric development more graphically shown at one glance than in a general view of the famous Colgate power plant, on the Pacific side of the Sierra Nevada mountains, in the northeastern part of California, some one hundred and forty miles by power-line from the cities of San Francisco bay. There, where the Yuba River gushes down between thousand-foot evergreen ridges in Yuba County, a long stone building squats close along the water's edge, with its back to a steep, rugged slope. Straight up that incline for a quarter of a mile the eye traces five enormous black pipe-lines that obviously come into the power house from a great wooden flume that is seen clinging high along the side of the mountain.

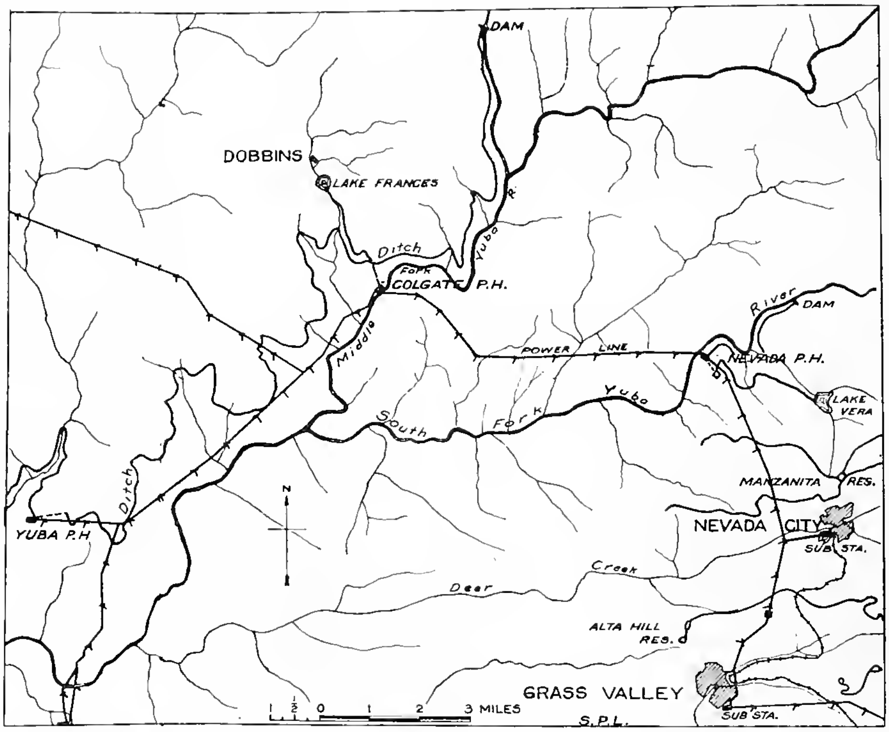
Eight miles upstream from the power house is a massive, granite diverting dam across a narrow point in the river canon. The river has hurried over its

rocky, gold-sprinkled bed for thousands of years, descending by many little rapids in making an aggregate drop of one hundred feet to the mile. But the big flume that ingenious man devised winds majestically along the precipices and slopes like a scenic railway, and by nice engineering preserves a gradual fall of twelve and two-thirds feet to the mile. So, by the time the flume water has arrived opposite the power house it is ready to take a single perpendicular drop of seven hundred and two feet, or more than four times the height of Niagara Falls.

That gentle diversion of an impetuous river to produce an artificial fall at a given spot and there convert the water power into definite energy, spouting from nozzles against water-wheel buckets, is the main principle of hydro-electric engineering. The greater the fall and volume of water, the greater the hydraulic power that can be obtained to turn the wheels of the big magnetic devices that generate electric current.

That remarkable flume is seven and six-tenths miles long, and it is seven feet wide and five feet deep. It is almost level full of water that rushes along with a flow of 12,000 miner's inches; a flow so swift that a man must be a Marathon runner to keep up with it; and so powerful that neither man nor animal ever gets out of it alive, if, perchance, the feet slip off the double plank which runs midway along on top of the cross beams that strengthen the box-like structure. Day and night watchmen walk those planks that are laid almost on the surging rush of water and half a thousand feet above the bed of the river.

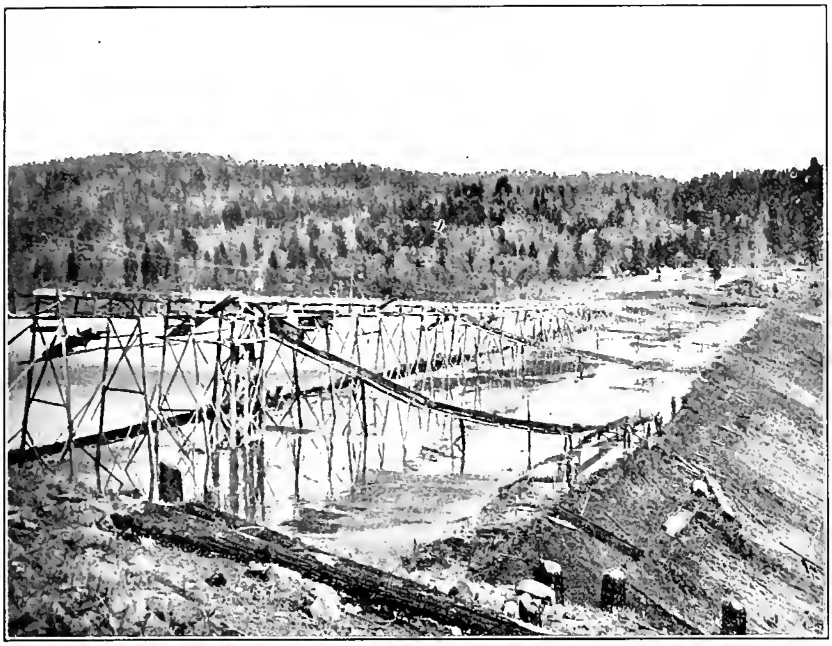
When that flow of 18,000 cubic feet of water a minute comes down the hillside through all five of those thirty-inch pipes, tapered to nozzle-ends the thickness of a man's arm, the water shoots out in four-inch streams more terrific in force than any fire engine ever produced, escapes with an impulse so great that you can strike the stream with a big sledge-hammer as though on an anvil. That silvery projectile of solid water will rend a board to splinters, or hurl a big rock clear across the canon and shatter it to fragments in transit. Such is the force of those condensed columns of water. They strike a horizontal undershot blow into the powerful steel buckets of the man-high impulse wheels, down under the power house, with a force of three hundred and four pounds to the square inch, a steady three-hundred-pound blow on every little space the size of a silver quarter-dollar, a constant ten-ton thrust against each water wheel. Such is the power of the water at the Colgate plant. And that tremendous battery of shooting streams turns the wheels that steadily generate nearly 20,000 electrical horsepower. Lessening demands for electric energy way off down in the big cities automatically deflect those movable nozzles so that only part or none of the stream strikes the buckets. And what escapes shoots free far across the canon.



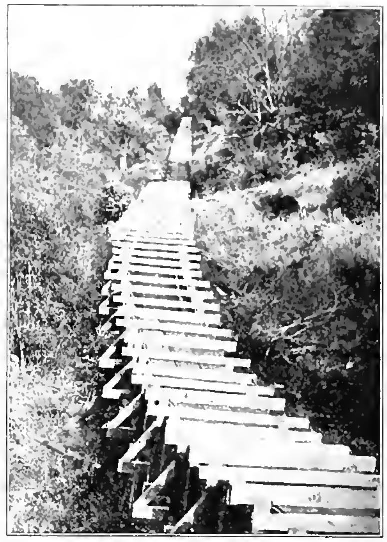
Map Showing the Colgate and Yuba Power Plants, the Ditches, Dams, Rivers and Power-Lines.

The Water Supply.

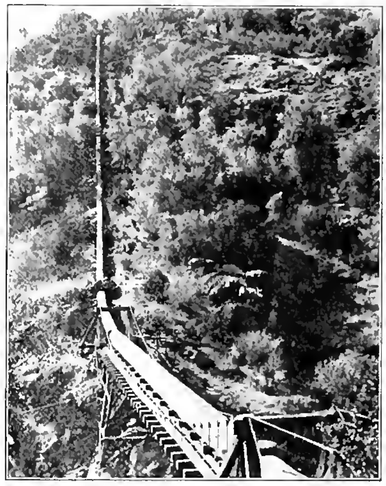
The catchment area above the dam—the high mountain ridges and forest slopes that drain the winter's rainfall and the summer's myriad springs and melting snows down into that particular canon—is



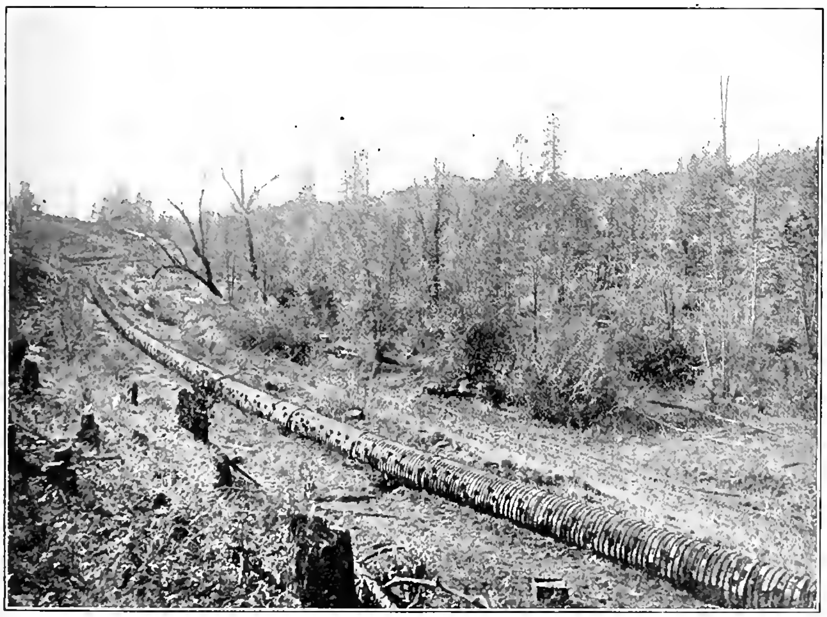
Lake Frances in the Making.



A Section of Rapid-Flume from Lake Frances



Inverted Syphon carrying Brown's Valley Ditch across Canyon below Yuba Power Plant.



The Stave Pipe-Line from Lake Frances to Colgate.

Clearing the Ground for Yuba Power Plant

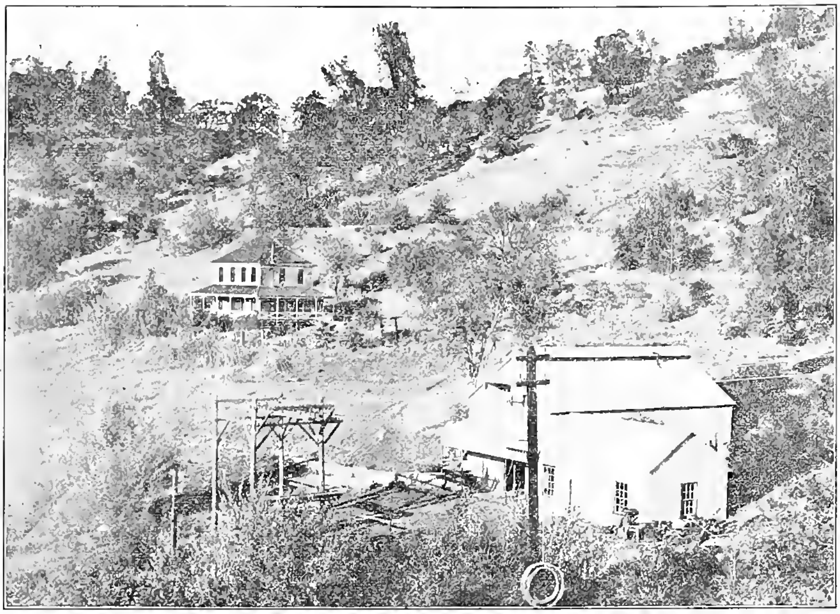
equivalent to a square tract of country a little more than twenty-three miles on each of its sides.

But to make sure of constant water power for the Colgate plant, to guard against any unforseen subsidence in the river's flow above the dam or against any accident to that long, wooden flume—through breakage, landslides, snowslides, or forest fires—there is an artificial lake up between the ridges, off to the left, two miles and a half behind the power plant, and three hundred and eighty-two feet elevation above the top of those five big pipe-lines that come down the ridge to shoot water against the wheels.

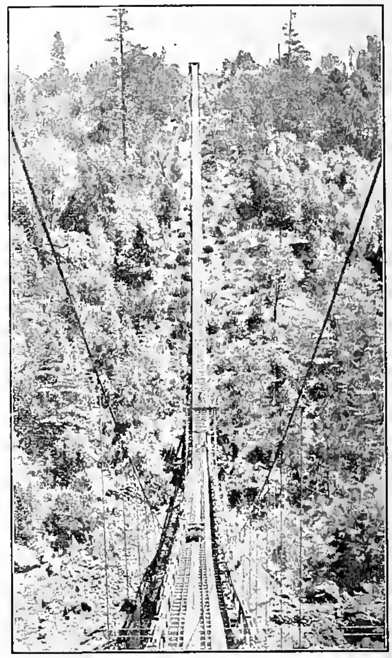
It is called Lake Frances, and it covers an area of one hundred and five acres and holds 92,870,000 cubic feet of water all the year round. It is as large as about fifteen city blocks. During the rainy season it catches the water drainage from the minor surrounding slopes, but its principal source of supply is the river flume itself.

The Yuba Power House.

Eight miles below the Colgate power house is the Yuba power plant, with a generating capacity of nearly one thousand horsepower. Historically, commercially, and sentimentally this smaller enterprise is the parent of the great Colgate plant. They produce and turn current into the same long-distance



The Yuba Power House and (at the Left) the Superintendent's Residence.



The Tramway and its Suspension Bridge.

power-line, and they get their water power from the same source. A generous part of the flume flow must ever go on past Colgate to preserve the original rights of the Brown's Valley ditch. Twenty-two miles of winding ditch brings the flow to a point above the little Yuba plant, and there it takes a perpendicular drop of two hundred and ninety-two feet through a single big forty-two-inch pipe. That water gushes against the Yuba impulse wheels and then, its fighting force expended, it flows gently on through twenty-five miles or more of winding ditch, traversing Brown's Valley, and doing only the quiet and peaceful work of irrigating lowland orchards and farms.

California's Wealth of Water Power.

To understand why it is that California is so wonderfully rich in water power you must bear in mind that there is a dozen or more of rivers rushing down from sources high in the lofty Sierras. Wherever water can be diverted and made to flow gradually along the side of a river canon to produce a single plunge of several hundred feet, there power can be developed to run an electric generating plant. How splendidly California is supplied with these steep rivers is indicated in the accompanying table, which gives the foot-drop to the mile for several well-known eastern rivers and for some of those in California. In this connection it will be recalled that the Yuba river slopes average of a hundred feet to the mile between the dam and the Colgate power house, and that the diverting flume is given a drop of less than thirteen feet to the mile. That flume slope is much greater than is really necessary. The mighty Mississippi goes to the gulf with a drop of only a little more than seven inches to the mile.

The steep descent of most of the California rivers enables power developers to locate more than one plant on the same diverted water system by leading the discharged water from the upper plant down by easy gradients to some point where another big drop can be produced.

River.	Miles Long.	Feet Descent.	Foot-drop to Mile.
Eastern:			
Mississippi	2,300	1,500	.6
Ohio	1,000	700	.7
Missouri	2,340	4,000	1.7
Connecticut	375	2,000	5.3
Kennebeck	150	1,000	6.6
Rio Grande	1,800	12,000	6.6
Hudson	300	4,300	14.3
California:			
Calaveras	68	1,000	14.6
Sacramento	400	7,000	17.5
Feather	136	4,678	34.4
Tuolumne	155	8,000	51.6
Stanislaus	113	8,000	70.8
American	118	8,500	72.0
Yuba	90	6,700	74.4
Cosumnes	93	7,500	80.3

Early Hydro-Electric Developments.

Having in mind now the peculiar fitness of California rivers for mountain power-development, it is easier to see how the plants progressed after a start was successfully made and long-distance transmission had become commercially possible. That the mysterious current could, without too much loss in power, be sent through a wire to a considerable distance from the place where it was generated was first demonstrated to the world in 1886 by the hydro-electric plant at Tivoli in Italy sending current seventeen miles to the city of Rome.

Thirty or forty years before that Italian plant had proven the city value of distant mountain water power California's miners had constructed amazing diverting ditches and had begun using the flow of mountain rivers to operate terrific hydraulic giants in tearing away hillsides and dissolving them to mud and stones in quest of settling gold. After the Sacramento river channel had been alarmingly filled in with these torrents of man-made mud and the farmers in the lowlands had been successful in having laws passed against unchecked hydraulic washings the costly mining ditch systems looked like a dead loss to those who had put money into their construction.

Next came irrigating schemes and a period of partial usefulness for the old mining ditches.

The Old Brown's Valley Mining Ditch.

Then came hydro-electric power plants! The very flume system that now supplies Colgate, the same ditch system that runs on more than a score of miles and supplies the Yuba plant and goes another score further with irrigation, has been in operation for years as the Brown's Valley ditch, carrying water for hydraulic mining in Brown's Valley.

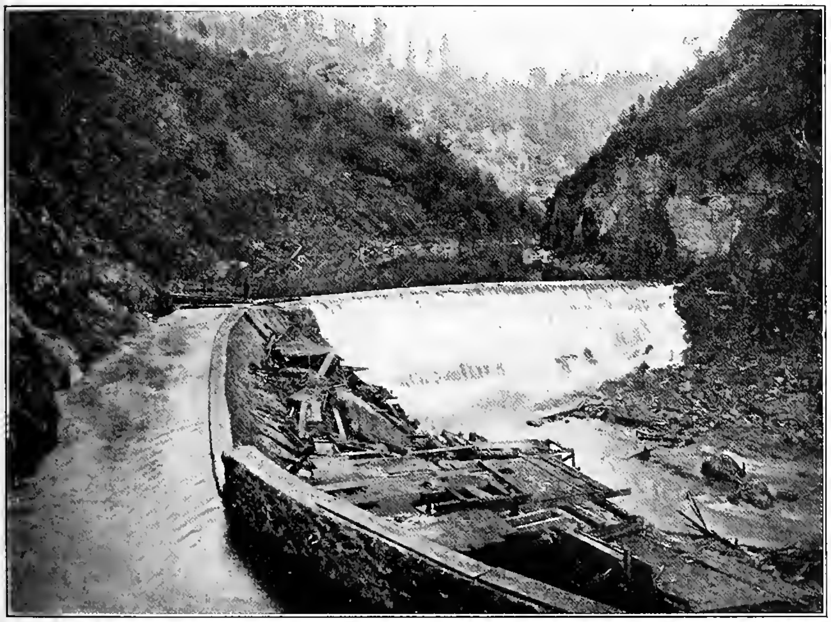
In the spring of 1895 the city usefulness of distant water power was first demonstrated in California with the completion of the power plant on the edge of the American River at the town of Folsom. Its electric current was successfully sent through a twenty-two-mile power-line into the city of Sacramento. Then, in February of 1896, after five years of effort in acquiring and developing the necessary water power, the Nevada power plant was started on the edge of the south fork of the Yuba River, down in a deep mountain ravine in Nevada County. And then that plant began sending electric current through an eight-mile power line to the towns of Nevada City and Grass Valley and their famous deep gold mines.

Eugene J. de Sabla, Jr., was the principal man behind the little Nevada plant on the south fork of the Yuba, and John Martin had taken the contract for its general construction.

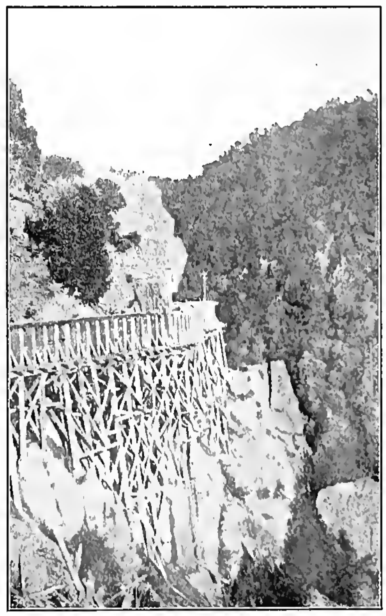
Hydro-electric power was a new thing, but it did not take de Sabla and Martin long to see that it was a good thing, and that not many miles away was that Brown's Valley ditch and a prospect of taking a good fall out of it. So, in September of 1897, they incorporated the Yuba Power Company, and had as a partner with them R. R. Colgate of New York City. Martin and de Sabla were San Franciscans.

Not a day was wasted on this new scheme. Within the record-breaking time of four months and five days after they decided to build the Yuba plant the thing was completed, was generating electric current, and, at the then almost appalling potential of 16,000 volts, was sending it on down twenty-two miles to the city of Marysville on the Sacramento River, where the Yuba joins the main stream.

It was in April of 1898 that this Yuba plant began operating. They had constructed a frame building covered with zinc-coated corrugated iron, and it stands there yet in a narrow, lonesome, tiny, upland valley between Dry Creek and the Yuba River and eight miles from the little town of Smartsville. The original installation then consisted of three 300-kilowatt Stanley generators. One of these generators has since been removed, leaving the plant with two, and a productive capacity of a little less than one thousand electrical horsepower. A big forty-two-inch pipe eight hundred and fifty feet long descends the oak-dotted hillside and ejects its flood of water through a large box-like compartment along the outside of the power house, the undershot flow revolving the two sets of wheels that turn the generators inside the building.



The Yuba River Dam from which Colgate Is Supplied.



A Difficult Point.

Within a year after the completion of the Yuba plant business had so increased and electric prospects so expanded that the promoters reorganized with a capital of $1,000,000 with which to buy out the Yuba Power Company and go in for bigger hydro-electric development further up on the Yuba River. They called this new concern the Yuba Electric Power Company.

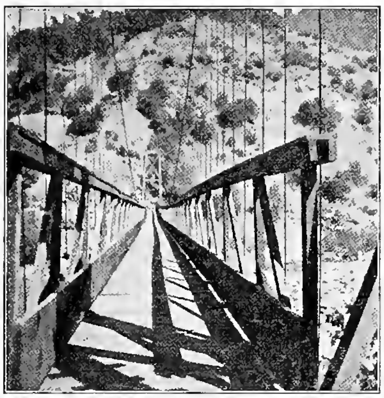
With an eye still on the course of that Brown's Valley ditch, they picked out a place on the middle Yuba where they could get more than twice the fall they had down at the little Yuba plant.

Site For the New Plant.

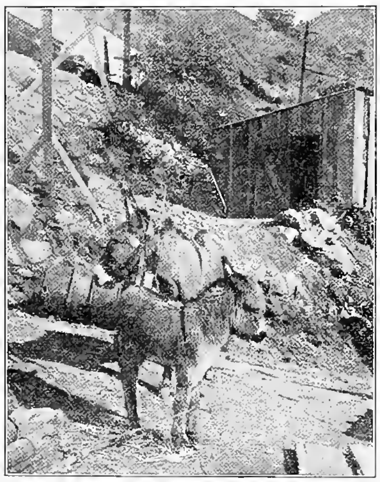
The spot selected was where the old Missouri Bar trail crossed the Yuba on the route between Dobbins and French Corral. Then they engaged W. R. Eckart to give his expert experience to the development of the flume for a greater flow. So the old flume that had wound along the canon side and been in use for ten years was supplanted by one almost twice as big, erected right along above it; and the diverting dam up-river on the north fork of the Yuba was strengthened and raised ten feet in height. As the dam stands today it spans one hundred and sixty-seven feet across the ravine and is forty feet high. It has a long wing sweep that diverts the water through concrete headgates, which open into the great flume.

Day after day, day after day, lumber poured down that chute tramway out of the sky, and the flume slowly stretched on down the canon, mile after mile, until they had used up just 8,000,000 linear feet of lumber, if you know what a lumber pile that makes! In places they blasted away the solid granite cliff and made a shelf, on turns they used long steel rods and bolted the flume securely to the native granite wall, and all along the way they braced it and gave it a foundation like a railroad trestle.

Then every two miles or so they scooped a little shelf and built on it a small house, with a porch overlapping the flume. These houses were the permanent camps for the flume-tenders, the forest-fire crews, the repair gangs of many carpenters that work along that structure for weeks in the summer. Later



Suspension Bridge across Yuba River at Colgate



Burro Brigade Packing Dynamite and Cement.

A Glimpse Across Lake Frances.

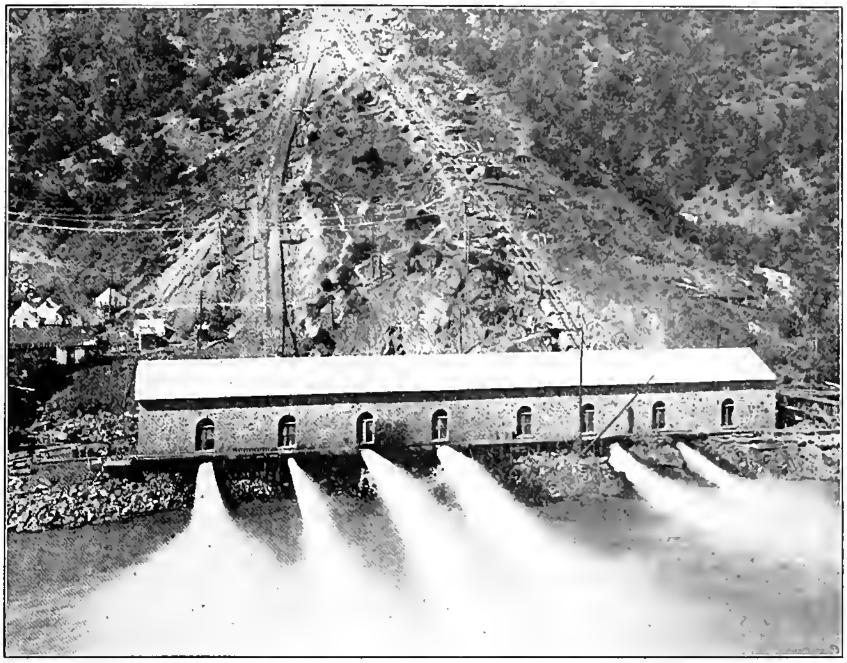
they stretched along the side of the flume a private telephone line with numerous stations from which to sound an alarm or to notify the plant that the flume had broken and that the water power would cease coming. One day a workman in a repair gang slipped and dropped a box of dynamite into the flume and then rushed to the telephone to warn the fellows down at the power plant to "look out" as it was hurrying their way. But the long watery trip must have safely soaked and diluted the explosive before it reached the penstock gratings and screens.

The construction of the dam was not so difficult. The native granite was right there. Only tools and dynamite and cement had to be packed up the river canon. But the building of those eight miles of flume, with all the necessary scaffolding, trestles, and the use of tons and tons of lumber was a real problem. Lumber mills were a long way off, and mountain roads steep. Ten miles across the thousand-foot ridges to the eastward of the dam was a good forest region, over in Nevada County, thick with cedar, spruce, yellow pine, and sugar pine of good size.

There a sawmill was established to turn out lumber for the new flume. The company still owns and operates that sawmill. They cut 11,000,000 linear feet of lumber, and then picked out the very best of it, the hearts of the logs, to use for the flume. Across the highlands that lumber was hauled and on to the top of the ridge, almost above the dam. Then they built a steep tramway coming down the mountain 1,275 feet like a narrow ladder reaching from the depths of the gorge right up to the blue vault of heaven. And the lower end of that ladder they curved into a dizzy suspension bridge that would deliver the well-strapped little carloads of lumber right over on the flume-side of the canon, where a space had been gouged out of the rock as a sort of landing shelf.

While the carpenters were rebuilding the great flume other gangs of workmen were carving a steep mountain road down from the direction of the little hamlet of Dobbins to deliver the heavy machinery. As the loads were to come down, the graders did not bother about any future loads that might have to be hauled up that terrible slope. So that road remains as a tedious, toilsome climb. While the roadmakers and the flumemakers were busy masons were getting ready the building. The high-walled canon daily resounded with the cannonading of dynamite where all three gangs were blasting out rock and clearing a way for operations. They dug down forty and fifty feet to get a virgin granite base on which to erect the Colgate power house, and then they built it solidly of granite and cement and lined it inside with cement

Romulus Riggs Colgate.



The Colgate P wer House.

and braced it with steel girders. The building, now twice its original length, is two hundred and seventy-five feet long and forty feet wide, has a cement floor, and it is absolutely fireproof.

The original part of the Colgate plant was completed and current from it was sent through sixty-one miles to Sacramento the 5th of September, 1899.

But even while operations were hurriedly going on to complete the Colgate plant electric demands so increased that the promoters began to see something of the great possibilities they were opening up for the valley and populous districts of California, where power was needed and wanted. So, in June of 1900, they reorganized again, this time with their capital stock $5,000,000, instead of $1,000,000. They called the new enterprise the Bay Counties Power Company, and, September 1st, 1900, they absorbed the Nevada power plant, over on the south fork of the Yuba. Eugene de Sabla was chosen as the first president of this enlarged concern, with William M. Preston as vice-president and attorney, and C. A. Grow as secretary and treasurer, and the directors were J. C. Coleman, Richard M. Hotaling, R. R. Colgate, and George A. Batchelder—all San Franciscans but the last two, and they were New Yorkers, Batchelder being the representative of an eastern banking house that had advanced $2,250,000 for the project.

Colgate Plant Doubled.

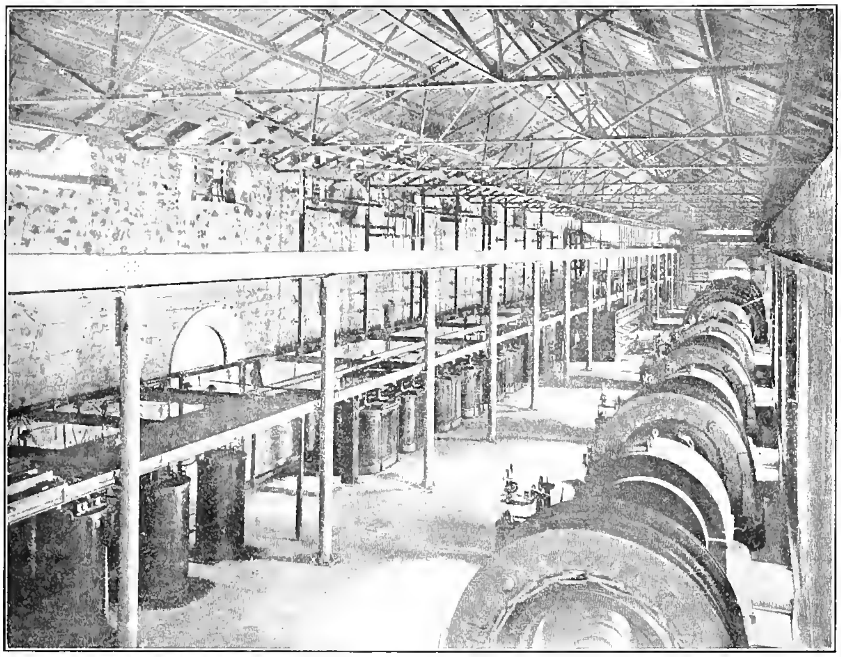
Within two years after the completion of the original Colgate plant the building was doubled in length and in producing capacity by an addition to the upstream end. The 27th of April, 1901, the Colgate plant did a historic thing in California power development. That day through its twin wires—one aluminum, one copper—it first transmitted high-voltage electric energy way through to the city of Oakland, a distance of one hundred and forty miles by the pole-line; and yet not a newspaper mentioned that epoch-making fact. Again the company reorganized and expanded to keep pace with business prospects, and (March 1st, 1903) took the name California Gas and Electric Corporation, with R. R. Colgate as president. And finally (January 2d, 1906) it became a part of the great Pacific Gas and Electric Company, with its present total of fourteen electric plants and eighteen gas works.

The Equipment at Colgate.

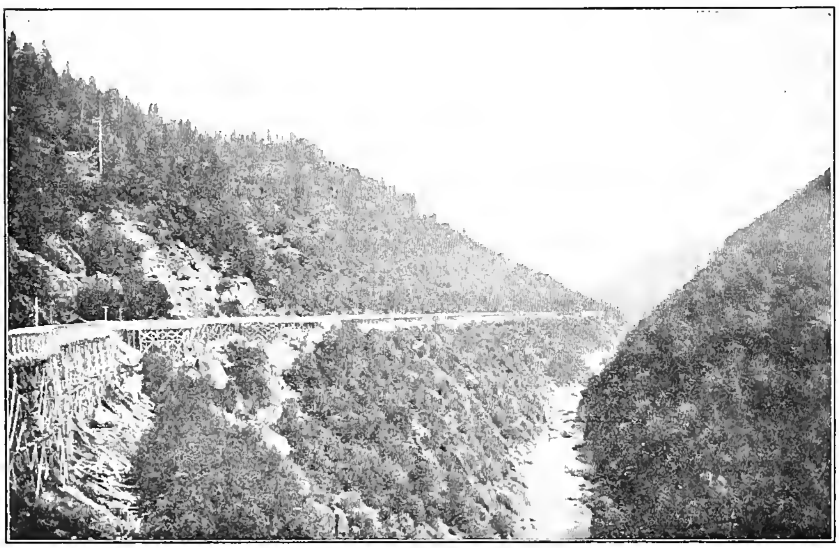
As it stands today the Colgate power plant contains six great electric generating machines and twenty-three transformers, and it has radiating from it five different high-voltage pole-lines traversing mountain ridges and valleys for more than 450 miles, and carrying enough big copper wire to span the American continent from San Francisco to New York. Two lines run through to Oakland, two go over the ridges into Nevada County, and one extends to Sacramento, all of them carrying a glisten of gold and silver threads spun as far as the eye can see through the clear air above the green Sierra ridges.

There are eleven impulse wheels at Colgate taking the drive of water from the five great pipe-lines that are anchored to solid cement blocks down the mountain side. Three of these wheels are eight and a half feet high, and turn at the rate of two hundred and forty revolutions a minute. Four of them are an inch under six feet high, and make three hundred and sixty revolutions a minute. Along beneath the building its entire length is a concrete-lined subway seven and a third feet wide by eight feet high and carrying all the bus bars and wiring of the entire station.

The installation at Colgate consisted first of three 900-kilowatt, 2,400-volt, sixty-cycle, three-phase Stanley generators and one 720-kilowatt, 2,400-volt, 133-cycle, two-phase Stanley generator. But when the



Interior View of Colgate Power House.



Four Miles of the C lgate Flume in Sight.

The transformers at first consisted of four banks, and three banks were added when the plant was enlarged. These transformers have been used in raising the generated voltage from 2,400 for delivery through different power lines first at 24,000 volts, a year later at 40,000 volts, two years later at 50,000 volts, and during the past seven or eight years steadily at 60,000 volts for all the high-tension lines. By thus making the voltage higher the electric energy may be more economically sent through a smaller and less expensive copper wire and then at the delivery end, by means of reducing transformers, it may be lowered for various commercial needs. Thus experience has shown that in long distance transmission of electric energy it is cheaper to have more tranformers at both ends of the line and be able to send high voltages through the many intervening miles of smaller copper wire, since pure copper runs into money.

All the transformers in the Colgate plant are oil-insulated and water-cooled. The exciters originally installed at Colgate are still in use after nearly eleven years' service.

The generator and transformer switches originally installed at Colgate in 1899 were of the air-break, knife-blade type. But when the plant was enlarged in 1900 they were all changed to Stanley oil-switches, and a little while afterward Stanley high-tension switches were put on the 40,000-volt lines. Two years later all the Stanley switches were replaced by Kelman switches, but the Kelman switches lasted only about four months. One was opened on a short circuit and caused a fire and a lot of damage in the building. So in 1904 Baum oil-switches were placed on all the high-voltage lines, and they have been in constant use ever since. These switches were invented by Frank G. Baum, formerly electrical engineer and then superintendent of the Pacific Gas and Electric Company.

plant was enlarged a year later a 2,000-kilowatt, sixty-cycle, three-phase, 2,300-volt Stanley generator was added; and in 1906 the 720-kilowatt generator of the original installation was moved and established at the upstream end of the building, and in its place was set a new 5,500-kilowatt, sixty-cycle, three-phase, 2,300-volt Westinghouse generator. All these generators are still in use.

The hydraulic installation consisted at first of two thirty-inch pipe-lines, with Risdon impulse wheels, two wheels on a shaft for each of the four generators. Later two more thirty-inch, cast-iron pipe-lines and one thirty-inch riveted steel pipe-line were added, with twin Risdon impulse wheels to drive each of the additional generators. And this general hydraulic equipment is also still in use.

EXAMINATION FOR WIRELESS TELEGRAPH OPERATORS.

The United States Civil Service Commission announces an examination on June 1, to fill three vacancies in the position of wireless telegraph operator at $1,200 per year each, in the Philippine Bureau of Posts.

STEAM

THE DISEASES OF BOILERS.[1]

BY F. S. ALLEN.

Boilers are heirs to nearly as many diseases as the human family. Some are crippled from birth, owing to errors in construction. The most marked and important of these congenital troubles is the one that makes itself known by the failure of the lap seam along a line which passes close to the rivet holes, but usually does not enter them, except when radiating branch cracks are present.

There were few failures from the lap-joint crack when iron plate was exclusively used in the construction of boilers, and this was doubtless due to two main facts,—first, the fact that the plates then used were small, and second, the fact that steel (which is now used almost universally for boiler shells) is much more likely than iron to develop this particular defect.

Certainly the workmanship was no better in the days of iron than it is now, and in fact it was, as a rule, probably distinctly inferior; and while the pressures that were carried were less than they are today, the boilers were no better adapted, by reason of design and construction, to bear those lower pressures, than modern boilers are to bear the higher ones that we find today.

A more important circumstance was, that in the use of iron it was impossible to obtain large plates. Thus boilers 4 ft. or more in diameter were made with two plates to a course, and a boiler 16 ft. long was usually built in five courses, and never in less than four. The girth seams doubtless stiffened the plates, for in the examination of a great number of boilers that had exploded by rupture of the seams it was found that the fractures commenced midway between the girth joints. In hundreds of cases, too, the main line of fracture has developed lateral branch cracks, which have been detected by the inspector because they showed just beyond the edge of the inner lap; and then by cutting out rivets and opening the joint longitudinal fractures have been discovered, without actual explosion of the boiler. Cracks discovered in this manner are always in the center of the course. Furthermore, in destructive tests of boilers we have found the distress to begin, and failure to occur, at the middle of the course. All of these facts show the importance of the stiffening action of the girth joints upon the shell.

Passing now to the consideration of the effect of the material itself, we note, first, that iron withstood the severe treatment of whipping down the ends of the plates with sledges—this practice having once been nearly universal in boiler shops. The only remedy for this is to provide a massive former, which, by heavy pressure, finishes the ends of the plates and brings the laps to as nearly a circular form as possible, though even with this precaution there is always some flattening at the lap.

[1]Condensed from an address before the New England Association of Electric Lighting Engineers.

Steel appears to resent the sledge-hammer treatment, and it is also sensitive to the slight local movements that occur near the joint, owing to variations of pressure in the boiler, and to the fact that the contour of the boiler shell is not truly circular near the joint.

Another defect that can be produced in riveted joints is due to neglect in adapting the pressure that is employed for closing the rivets, in hydraulic riveting (which is the best method of riveting), to the nature of the joint that is being made. The pressure that is maintained upon the accumulator should be varied according to the diameter of the rivet that is to be driven, and the thickness of the plate of which the shell is to be made.

Ruptures of plates from these causes occur with little reference to factors of safety, or to the age of the boiler. They sometimes develop within a year or two, while in other cases they do not appear until after several years of service.

Alteration of the structure of the boiler, under the influence of stress and temperature, is undoubtedly the cause of failure in many cases, and evidence of the fatigue of metal, which admittedly occurs in all classes of machinery, is found in boiler plates. Fractures in the plates, away from the seams, have been found occasionally, and surface cracks, either internal or external, may develop in the shell, the plates being then brittle enough to be readily broken up with a hammer when they have been removed from the boiler. Such cracks are not so frequent, in the central or free parts of the plate, as they are near a flange or some other rigid connection, where the effect of the movement of the plate may be localized. The localization of strains in this way has been the cause of frequent failure or fracture in some types of boilers, with the result that expensive repairs have been required, and in many cases explosions have resulted.

We also find evidence of profound alteration of the structure of the material in boiler tubes, these often losing their ductility after a few years of service, even though they may have been reasonably ductile when new. Undoubtedly the skelp from which these tubes were made was of an inferior quality; and the alteration in their structure, with the resulting liability of fracture, is probably due to the temperature to which they are exposed, rather than to the pressure.

Of late there are many defective bolts found among those that are used for holding the tube caps on the manifolds in some types of water-tube boilers. This is a dangerous defect, as most of these boilers are operated under high pressure, and the caps are upon the outside, so that the failure of the bolt releases the whole contents of the boiler into the fire-room. This matter is so serious that it has been taken up by one of the large electric-road operators, and chemical tests have been made of the various bolts in actual use, and of the bolts purchased. The number of defective bolts found during the past year was very great, while ten years ago it was the exception to find any such bolt defective. I cannot say what the result of the investigations now going on in my department, and among steam users, will develop, but from personal investigation I believe that the bolts that have been used for the past few years are of steel, and evidently they are commercially-made bolts. The ductility of many of

the defective bolts is so far reduced that, though they are an inch in diameter, a blow from the light hammer used by the inspector would snap them off with a single blow. Many were also found to be cracked partially through.

With regard to these bolts I would say that the remedy, in my opinion, would be to use bolts that are forged from the very best quality of Swedish iron. These bolts are not subject to alternating or intermittent variations of stress, and hence it appears probable that the change in molecular structure that they undergo is to be ascribed to the natures of the material from which they are made, the alternation taking place as a result of the temperature to which they are exposed.

One other cause of rapid deterioration and loss of efficiency in boilers is the formation of incrustation and scale. Water-tube boilers are peculiarly sensitive to this, as their tubes are liable to become overheated, and the thin material of which they are made then becomes subject to distortion, where the relatively heavy plates of a boiler shell would remain comparatively unaffected. A great many cases of this kind occur yearly, and the rupture of the tubes is not infrequent.

Some twelve years ago several tubes ruptured in one of our best equipped and largest electric plants, and overheating of the lower tubes was noted in all the boilers. Many were quite badly affected, and others not so seriously. Some of the least affected tubes were selected, and many specimens taken from there were sent to Watertown, Mass., for test. The results were of considerable value. The rapid deterioration of the tubes was considered to be largely due to the feed water and to the nature of the incrustation. A change was made in the water supply, and I do not recall any trouble with tubes experienced at this plant since.

The failure of tubes in water-tube boilers is not infrequent. It is sometimes due to defects in construction or in welding; but I have noted one peculiar fact, which has impressed me considerably, and that is, that except in cases in which the weld was defective, I have not noted a single case in which the failure occurred directly at the bottom of a tube. This fact may be of little interest, but it has impressed upon my mind the view that structural change in the material, leading to the failure or splitting of the tube, takes place a little towards one side of the bottom, or (say) at "about eight o'clock" in the circle of the tube.

The increase of temperature attendant upon the use of higher pressures has brought about some new developments, detrimental to boilers, in connection with the formation of scale, and this is especially true in the fire-box type of upright boilers. There is little space, in these boilers, for the deposit of scale upon the tube sheets directly over the fire, and in view of the large amount of heating surface and the normal evaporation, the formation of scale must be very rapid upon the tube sheet, especially when the feed water is at all brackish. Two marked instances are worthy of notice, the observed results seeming hardly credible. In both cases the boilers were nearly new, and were of good construction, and working under proper factors of safety. Leakage around the tubes developed quite early.

In one of the cases the trouble occurred in a battery of very large boilers of this upright type, operating at a pressure of 170 lb. per sq. in.; the owners in this case (as well as in the second one, presently to be noted) having a large number of boilers of the same type operating at 125 lb. There had never been trouble from scale, although in the older boilers, operated at 125 lb., there was a considerable deposit of mud which was readily removed by periodical washings. No trouble from leakage had been experienced from this sediment at any time, in any of the boilers of this plant, until the new high-pressure boilers were installed for electric power; and the plant was thoroughly modern and up-to-date, and everything of the best construction. An examination of the high-pressure boilers, after the leakage around the tube ends had developed, showed a thin, hard coating of sulphate of lime over the whole tube sheet, and making a slight fillet around each tube. The coating resembled an enamel lining more than a scale, owing to its extreme thinness, and its adherence to the plate. The fact that the same water had been used in boilers in operation in this plant for over twenty years, and that no trouble had occurred from scale or deposit, made it difficult to persuade the engineer that the leakage was due to the feed water, and to scale formation; but by the judicious use of solvents the enamel-like coating was finally dissolved, and no leakage has occurred since, solvents being now used to prevent further deposition of scale.

The second case was similar to the first, but the plant was many miles away, and used an entirely different water. Nevertheless, the same kind of action took place in the boilers that were operated at 160 lb., although boilers in the same room had been operated on the same water, with entire success, for twelve years, at 125 lb. This second case also yielded to treatment, and the affected boilers have since been running at their maximum capacity without leakage or trouble of any kind.

By way of explanation we may assume that the difference between the temperature, due to 125 lb. pressure, and that due to 160 lb., was sufficient to cause the precipitation, in each case, of a small quantity of sulphate of lime, which, at the lower temperature, had remained either in solution, or in suspension with the mud that had been washed out so readily.

The importance of eliminating all lubricating oils from boilers is almost too well known to be worthy of mention, yet oil continues to be a great source of injury and destruction, where the water of condensation is recovered from the exhaust steam, and used over again in the boilers. Separators are put in, having a nominal capacity based upon the area of the exhaust pipes, without reference to the volume of steam that these exhaust pipes are to carry. This is a grave error, in many cases. Separators have capacity, as well as other machinery; and in installing an oil separator, care should be taken to ensure for it a capacity sufficient to handle the full volume of steam passing through it.

There also seems to be much difficulty experienced in removing oil from boilers, when it has once

effected an entrance. This can be done readily, in some types of boilers, by swabbing the sheets and tubes with a mop dipped in kerosene oil, after taking the highly important precaution of extinguishing all open lights about the boiler, as a measure of safety. In other cases, where the boilers are inaccessible for mopping, they can be boiled out with a strong solution of soda ash (or caustic soda if the soda ash does not prove effective), with a generous addition of kerosene oil, the pressure being maintained at half or two-thirds of the regular working pressure for from twelve to twenty hours. After this treatment the oil can usually be washed out in the form of a curd.

Corrosion, another boiler disease, is not so common today as formerly, but it still is an active enemy of steam boilers. I say it is less common than it was formerly, because a great change has been made, in the last few years, in the types of boiler in general use, and those that are at present most common are less liable to corrosive action than were the drop-flue, hammer-head, and similar types having a poor circulation at the bottom. We still have with us some types in which there is a tendency to corrosion, and no universal remedy can be relied upon. Instead, each case must be carefully investigated, and a remedy applied that is appropriate to the cause of the difficulty. Where the water is pure and the boilers are operated intermittently, corrosion is frequently found in the form of pitting. This action takes place very often in pumping stations, and in power plants and electric stations where the fires are kept banked for long periods, with the water in the boilers quiescent, and far less often in boilers that are always in active service. Boilers that are used exclusively for heating purposes suffer more than any others from pitting.

Once started, corrosion is likely to go on until the material of the boiler is destroyed, unless measures are taken to check it. When corrosion is observed in connection with the use of a pure water, one of the best methods of treatment is to keep the water alkaline with soda ash, for this tends to check the corrosive action, and the soda does not injure the boiler.

Care should be exercised, in selecting feed water for a new plant, or for a new location of a plant, to see that the quality of the water is good. Nitrates in the water should be especially avoided, as they are especially troublesome and dangerous. The presence of nitrates commonly results in the formation of a light scale coating, under which an active destruction of the material of the boiler goes on, the plates and tubes becoming wasted away, and the braces and rivet heads cut off.

In certain types of boilers the breakage of staybolts is a frequent and annoying, as well as expensive, occurrence. Such bolts are often drilled with a 3/16-in. hole, which either passes through the entire length of the bolt, or at least goes in deeper than the thickness of the outside sheet: and such holes are supposed to give absolute safety, so far as the detection of broken bolts is concerned, the theory being that steam will escape from the end of the bolt as soon as fracture has occurred, and thereby call attention to the trouble. The drilled hole is not to be relied upon, however, because, in the process by which the staybolt fails, the fracture will creep into the bolt slowly, and when it first encounters the hole, moisture from the boiler will leak out through it in very slight quantities, and evaporate without attracting any attention. In evaporating, however, the moisture leaves behind it a certain amount of solid matter, and this accumulates until it forms a hard, baked residue, completely choking the opening in the center of the bolt, so that the apparent absence of leakage leads to a sense of security which is far from corresponding to the actual facts. Many bolts that have been drilled, for the purpose of providing security against undiscovered fracture, have been found to be completely broken off, and many others have been found to be partially broken, without any noticeable leakage occurring in either case. It will be plain, therefore, that if any reliance is to be placed upon the drilled staybolt, it is important to ream out the holes frequently, and keep the openings free. The breakage of staybolts is sometimes due to circumstances connected with the environment of the boilers, to their exposure to injury from external causes, to strains from varying temperature and differential expansion, and to faulty construction or poor material in the bolt.

Many of the minor diseases of boilers, such as rapid losses of ductility, and development of incipient fractures at different parts (as at the girth joints in the plain tubular boiler), may be due to the conditions under which the boilers are operated, such as to the varying level of the water, and to the introduction of cold feed water, or to blowing down the boiler under high pressure and leaving the drafts on, so that cold air may be drawn through and so give rise to serious unequal contraction, or to pushing the fires too hard in raising steam from cold water. Several strains, resulting in leakage at the seams and around the staybolts and tube ends of fire-box boilers, are frequently caused by the burning out of the fire under one boiler of a battery, while this boiler is left connected with the rest of the battery, and with the draft full on. All these defects are developed by poor practice or management.

Just a word, in conclusion, about the action of superheated steam. When superheating is done in connection with steam generators, the elasticity and strength of the material are affected if a high temperature is produced, and I look forward with considerable anxiety to the results that may follow when boilers are operated in this way for a term of years. It has come under my own observation, that cast-iron is an unsuitable material to use, for exposure to superheated steam of high temperature. I have in mind some extra heavy valves of the best make, with cast-iron bodies, which, when exposed to superheated steam at high temperature, became badly checked and marked, so that the whole body of the casting had an appearance suggestive of the crazy cracking observed on imperfect crockery. These valves were replaced by others in which soft steel castings of the best quality were used in the place of the cast-iron, and the new ones have thus far, I believe, shown no defects. Fittings or manifolds of cast-iron, connecting superheaters with the generator, should not be indorsed or approved for superheating to 100 degrees or over. In fact, I think that cast-iron for such purposes has already been abandoned in the best practice, forged or wrought iron being substituted for it.

CALIFORNIA FUEL OIL.

BY R. F. CHEVALIER.

Combustion.

Combustion is the phenomena that takes place when chemical reaction occurs between oxygen and a combustible element. The combination is usually accompanied by heat and light. Combustibles are substances that are capable of rapid combination with oxygen to produce light and heat, the oxygen being classed as a supporter of combustion.

The elementary substances entering into the composition of fuel oil are carbon, hydrogen, oxygen, nitrogen and sulphur. The combinations of these elements are always made in definite proportions.

The atomic theory should be understood for a clear conception of this combination. If oxygen and hydrogen combine in the exact proportion of two volumes of hydrogen and one volume of oxygen the result is water. When this water mixture is maintained in a gaseous condition, it will only occupy the space of two volumes, although for its production three volumes were supplied.

According to this theory the smallest conceivable particle of an element that enter enters into combination is called an atom. Molecules are the individual particles resulting from their union. Simple substances as well as compounds have their molecules. A molecule of a simple substance generally has more than one atom in it, but never contains atoms of more than one kind, whereas a molecule of a compound substance always contains more than one kind of atom. The dimension of an atom has never been satisfactorily determined.

The various elements are designated by symbols which are generally the initial of their names, and when necessary for distinction, followed by the succeeding letter. The supposition is that all atoms are of the same size, therefore an element occupying the same volume, at the same pressure and temperature of another have the same number of atoms, but the weight of the two being different. The relation is known as the atomic weight. Hydrogen is the lightest of all known substances and is therefore taken as unity. A given volume of oxygen will weigh sixteen times as much as the same volume of hydrogen. The atomic weight of hydrogen is 1, that of oxygen 16.

The symbol for hydrogen is H, that for oxygen O. When combinations of two or more elements take place, and more than one volume of either enters into the combination, the proportion is designated by a suffix to the symbol of the plural element. For example, the formation of water requires the combination of two volumes or atoms of hydrogen and one volume or atom of oxygen and is represented by H_2O. From this atomic combination the weight of the mixture is easily determined. The atomic weight of H is 1, that of O is 16. We have

2 atoms of H + 1 atom of O = 2 + 16 = 18.
$H_2O = 2H + 16\ O = 18\ H_2O$.

The symbols and atomic weights of the four principal chemical elements found in fuel and the air used for its combustion will be found in table No. 2.

TABLE NO. 2.

Name.	Symbol.	Atomic Weight.
Hydrogen	H	1
Carbon	C	12
Nitrogen	N	14
Oxygen	O	16
Sulphur	S	32

Oxygen is a colorless gas, the universal supporter of combustion and is mixed with the nitrogen of the air in the following proportion:

21 parts O and 79 parts N by volume.
23 parts O and 77 parts N by weight.

A small quantity of oxygen exists in the fuels. Oxygen at atmospheric pressure, temperature 32° F., weighs .088843 lbs. per cubic ft. A pound of air contains .2315 lbs. of oxygen or 4.32 lbs. of air contain 1 lb. of oxygen.

Nitrogen is a colorless gas, diluting the oxygen in the air. Entering the furnace with the oxygen at a low temperature, it passes through the furnace and up the stack, carrying away considerable heat. It is the greatest source of loss in the operation of a steam boiler. Its weight per cubic ft. at atmospheric pressure, temperature at 32° F., is .07831 lbs. A pound of air at the same pressure and temperature contains .7685 lbs. of nitrogen.

Hydrogen is the lightest of all gases, has a great affinity for oxygen, the first claim to the supporter of combustion, and the supposition is that it must be satisfied before any other constituent of the fuel. Its weight per cubic ft. at atmospheric pressure, temperature 32° F., is .00559 lbs.

Carbon is the most widely distributed of all the combustible elements. When brought in contact with oxygen, with an elevation in temperature, a chemical combination takes place. Providing sufficient oxygen is present, each atom of carbon will combine with two atoms of oxygen, forming a compound known as carbon dioxide, the symbol of which is CO_2. The process of this combination may be shown by the formula $C + 2\ O = CO_2$. The quantity of oxygen present during this reaction may be many times in excess of the required amount but it will not enter into combination with the carbon in a greater proportion than one atom of carbon and two atoms of oxygen.

The combination of oxygen and carbon forming a carbon dioxide gas is therefore the result of complete combustion. From table No. 2 the atomic weight of the combination is easily obtained as follows:

C — atomic weight 12, O atomic weight 16, $1C + 2O = 12C + 32O = 44CO_2$.

With an insufficient supply of oxygen one atom of carbon combines with one atom of oxygen forming carbon monoxide—CO. This is a colorless gas, and with the addition of more oxygen, providing the temperature is sufficiently high, will combine with another atom of oxygen forming, as already shown, carbon dioxide or CO_2.

Sulphur is found in very small quantities in fuel. It is objectionable, as the gas formed by its combination with oxygen, SO_2, attacks the metal of a boiler, causing corrosion. It has but slight heat value.

Combustion in General.

The two principal elements entering into the combustion of any fuel are carbon and hydrogen. Upon the application of heat a portion of these elements

form a series of compounds termed hydro-carbons, and that portion which does not unite in this combination are known as fixed elements. The condition that exists while the combination of these elements is going on is such that it is impossible to determine the order of dissociation, but we know that the final results of perfect combustion should be carbon dioxide (CO_2), water (H_2O) and nitrogen (N).

(To be continued.)

PRACTICAL MECHANICS—PAPER 13.

Involute Gearing.

In the involute system of gearing we have, instead of the describing circles of the cycloidal system, a describing line which is tangent to a base circle.

If a cord were wrapped around a circular disc and then slowly unwound from the disc, the cord in the meantime being kept tightly drawn, the end of this cord would describe what is known as an involute of revolution. Fig. 14 shows such an involute. The portion of this involute immediately adjacent to the circle is used for the tooth profile.

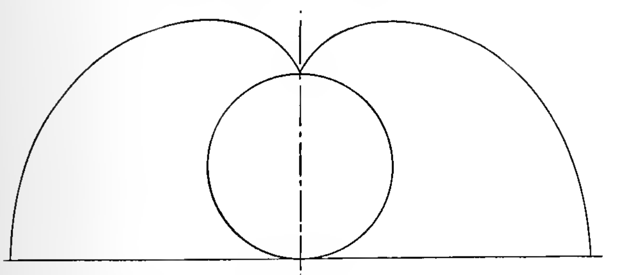


Fig. 14.

Imagine two circular discs rolling together, on which discs are drawn two circles slightly smaller in diameter. Through the point of intersection of the discs imagine a straight line drawn so that it will be tangent to each of the inner circles above mentioned.

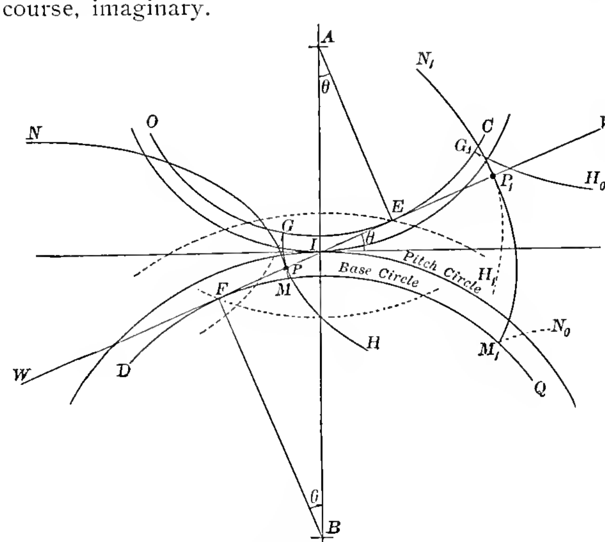
Now if the discs be rotated, thus causing them to roll one upon the other, this common tangent line will move in a constant direction parallel with itself and always tangent to both of the inner circles. It will also constantly pass through the point of contact of the two discs.

Fig. 15 shows two such discs as we have described intersecting at the point I and with centers at A and B. The smaller circles mentioned are designated by the arcs O, E, C and D, F, Q respectively. The line W I W is the tangent line above mentioned, which, as will be seen, is tangent to the inner circles at the points E and F.

Suppose that the two discs are rotated so that the common tangent line W I W will move to the right and upward, i. e., the disc with center B rotating clock-wise; and further suppose that the point F is for the moment considered as a point common to both discs. That is, imagine disc with center A attached to a larger disc such that the larger disc would overlap disc with center A and the circumference of which larger disc is represented by the dotted arc through the point F. As the line moves, due to the rotation above imagined, the point F will move toward I. If successive points were plotted showing actual positions of the point on this line, it is evident that these successive positions will describe an involute on each disc. Such successive positions of a point in the line are shown by the curves G P H and M P N, the point being the describing point.

If the discs were sufficiently extended and the rotation continued far enough, this point P would actually pass through all points on the curve M P N with reference to the lower circle and would pass through all points on the curve G P H with reference to the upper circle. Thus it is seen that the point of contact between two tooth profiles will move along the line from the one point of tangency F to the other point of tangency E.

The inner circles which we have been considering are called base circles, while the disc circumferences are the pitch circles. In actual practice these are, of course, imaginary.



From LeConte's "Mechanics of Machinery."

Fig. 15.

The driving must necessarily all be done between the points F and E and hence the length of the teeth is determined by distance between the base circles. In actual practice the tangent line is ordinarily given an angle of 15° with the common tangent to the pitch circles at the point I. A greater angle of obliquity would permit of longer teeth and a larger arc of action, but would, on the other hand, cause more friction and would, in addition, reduce the strength of the teeth.

It will be seen that, with the involute tooth outline, it is possible to vary the distance between shafts slightly without affecting the constancy of the angular velocity ratio. Such relative movements of the shafts would not affect the base circles and hence their involutes remain unchanged. As the shafts are separated, however, there would be an increased back-lash, and since the angle of obliquity would be increased by such separation, the arc of contact would be greater and the strain would consequently fall nearer the tips of the teeth.

The dimensions of the teeth and other considerations of design may be the same as in the cycloidal system, described in paper No. 12. Therefore, in our next paper, we shall proceed with the practical methods of gear design in accordance with the two systems which we have outlined.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

(Continued.)

CHAPTER VII.

MAINTENANCE AND TESTING.

The care and maintenance of recording watthour meters should receive the most careful attention from distributing companies, and only competent men should be placed in charge of the meter department, because, as pointed out in Chapter I, negligence in the proper care of the meter system may result in a serious financial loss. It is therefore essential that the distributing company be equipped to test and make minor adjustments of its meters. In order to secure the best results it is necessary that some systematic method of inspecting and testing be adopted. Almost all of the larger companies, realizing the importance of meter accuracy, have separate and well-organized meter departments which are equipped for testing, repairing and re-calibrating service meters, this department being held responsible for their proper operation.

With small companies it is often impractical to have a separate meter department, but it will be found, even by the smallest distributing companies, that it is economy in the end to have some systematic method of testing and caring for meters. In small stations, where the size of the system so warrants, it is advisable to employ the entire time of at least one man to see that the meters are kept in proper condition; where this is not warrantable, it can usually be arranged to have the same man do all of the meter work, rather than having two or three men, each doing a part of it, because where there is one man, the responsibility is then definitely placed, and furthermore, he becomes more efficient and he will usually take more interest and pride in seeing that his meters are always in the best of condition.

Reading the Meter and Keeping of Records.

The interval between the readings of each individual meter should be as nearly uniform as possible, because if the interval is greater for one month than it is for the next, the customer's bill will as a rule be correspondingly affected, which will in a great many cases lead to dissatisfaction on the part of the consumer, with the resulting annoyance and explanations necessary on the part of the distributing company. The best way in which to obviate such troubles, and to insure a uniformity of meter reading is to begin each month at a fixed date and always have the meter-reader go over the route in the same order.

In reading meters it is usual practice to have a special form of "loose-leaf" book which has on each page twelve (or six) facsimile prints of the meter dial, upon which can be marked the corresponding position of the pointers. Such a card is reproduced in Fig. 80, the reverse side of the card being used for any notes which may be necessary. The meter reader should first note the actual reading of the meter and put the figures down in the column set aside for this purpose; he should then copy the exact positions of all of the pointers. By taking both readings thus,

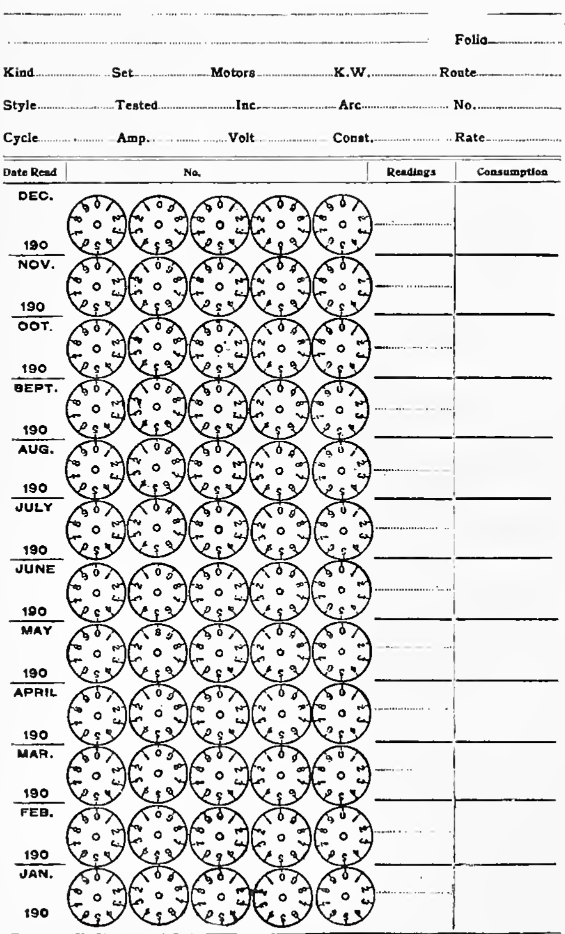


Fig. 80.

Our No. ....C.........Mfgrs. No. ....

Location of Meter ....

DATE READ	READING		READ BY
JUNE	FORWARDED	KW	
JULY		KW	
AUG.		KW	
SEPT.		KW	
OCT.		KW	
NOV.		KW	
DEC.		KW	
JAN.		KW	
FEB.		KW	
MAR.		KW	
APR.		KW	
MAY		KW	
JUNE		KW	

Fig. 81.

METER TESTED ....

FOUND.......................% FAST.

" ....% SLOW.

LEFT...

C = dial constant.

OLD FOLIO No...................

" LINE No........................

Rate...

Min. Monthly Bill $.............................

Connected Load.................................

Date Read	Reading	Difference	C	K. W. Consumption		Amount of Bill
					SILENT READINGS	
July	K. W.	K. W.		K. W.		DISC $ NET
Aug.	K. W.	K. W.		K. W.		DISC $ NET
Sept.	K. W.	K. W.		K. W.		DISC $ NET
Oct.	K. W.	K. W.		K. W.		DISC $ NET
Nov.	K. W.	K. W.		K. W.		DISC $ NET
Dec	K. W.	K. W.		K. W.		DISC $ NET
Jan.	K. W.	K. W.		K. W.		DISC $ NET
Feb.	K. W.	K. W.		K. W.		DISC $ NET
Mar.	K. W.	K. W.		K. W.		DISC $ NET
Apr.	K. W.	K. W.		K. W.		DISC $ NET
May	K. W.	K. W.		K. W.		DISC $ NET
June		K. W.		K. W.		DISC $ NET

METER INSTALLED

OUR NO.	MFRS. NO.	C	IN	OUT

Check Meter

Rented Meter Charge

Fig. 82.

one acts as a check on the other, and with a little practice a man becomes efficient and accurate.

Some distributing companies use the form shown in Fig. 81, which does not provide for the check afforded by having both the direct reading and the positions of the pointers copied. There is a great difference of opinion as to the most advantageous method of transcribing the meter readings to the record book. The objections advanced against the method of copying the positions of the meter pointers is the fact that it takes considerably more time than it does to simply transcribe the numerical value direct; it also involves more work on the part of the book keeping organization, and there is also liability of error when the book-keeper transcribes the reading from the meter reader's book to the record book.

The method of simply transcribing the reading numerically is undoubtedly the most rapid and the most satisfactory if a well experienced and careful man can be employed for this work, but the method of transcribing numerically and also copying the positions of the pointers is usually to be preferred on account of the check which it affords.

Figure 82 represents a very convenient form of file-card which may be used for the office records and to which the figures from the reader's book are transferred; the reverse side of the card is similar and the record may be continued thereon. Under no conditions should the record cards be taken from the files.

It is not infrequent that check readings have to be made, sometimes at the request of the consumer and sometimes because of apparent discrepancies in the monthly reading. When such readings are taken it is advisable to use a "re-read" card of a form similar to that shown at (a) in Fig. 83. Fig. 83 (b) shows a convenient form of record blank for use in testing meters.

METER TEST REPORT.

Request Date..........................

Name ....

Address ....

Location of Meter..

Company No................. Size...............Amps.

Mfgr. No.................... ....Wires

Make.............Type....... ....Volts.

Testing Constant............Reading Constant............

	FOUND		LEFT	
	.....% Slow	.....% Fast	.....% Slow	.....% Fast
¼ Load				
½ Load				
¾ Load				
Full Load				

METERED LOAD

2 Cp.	4 Cp.	8 Cp.	16 Cp.	32 Cp.	Arcs	Fans	Misc.

Other Appliances

....

....

Remarks: ....

....

....

....

....

....

Date Meter Tested ....

....

Meter Tester.

N. B.—If these Requests fail to follow in Numerical Order promptly advise Accounting Department

Fig. 83a.

Folio
Line

RE-READ METER

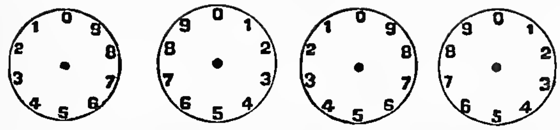
2M—De.Co—8-08

Date issued ....

Mr. ....

Address ....

Reading { *Watt Hrs.* ....
{ *K. W.* ....



Meter Number .... *Constant* ....

Date Read .... *By* ....

(Use back of this slip for remarks.)

Fig. 83b.

During the regular, or periodic, testing of service meters, there will invariably be found a number of slow meters and it is good policy to use a card similar to Fig. 84, so that the consumer may expect the

DEAR SIR:

Your meter located at..........

being our No.__________upon being tested has been found________%

slow. Fearing that any additional billing on your previous consumption would be inaccurate, and possibly unjust to you, we are not rendering any additional bill, but are standing whatever loss has been incurred.

We trust all this is satisfactory.

Yours truly,

Fig. 84.

next bill to vary from the last one. Such precautions involve very little time and expense, and in many cases they save heated arguments and preserve the good will of the consumer.

Too much stress cannot be laid upon the systematic keeping of the data regarding the individual performance of the meters, and for this purpose it is advisable to keep record cards similar to that shown

Date Tested ____Testing Const____					Date Rec'd ____Testing Const____				
	%F/S		%F/S			%F/S		%F/S	
	FOUND		LEFT			FOUND		LEFT	
¼					¼				
½					½				
Full					Full				
Date Tested ____Testing Const____					Date Rec'd ____Testing Const____				
	%F/S		%F/S			%F/S		%F/S	
	FOUND		LEFT			FOUND		LEFT	
¼					¼				
½					½				
Full					Full				
Date Tested ____Testing Const____					Date Rec'd ____Testing Const____				
	%F/S		%F/S			%F/S		%F/S	
	FOUND		LEFT			FOUND		LEFT	
¼					¼				
½					½				
Full					Full				

Fig. 85a.

in Fig. 85, (a) being the front side and (b) being the reverse side. Such data will give an accurate and ready insight into the continued performance of the individual meters, and will act as a guide in the future selection of the best meter for the service of the existing conditions.

ELECTRIC METER RECORD.

OUR NO.	MANUFACTURER'S NO	MAKE	AMP	VOLTAGE	WIRE	CONSTANT	TYPE

DATE SET	READING	NAME	ADDRESS	DATE OUT	READING

Fig. 85b.

Installation of Meters.

With few exceptions, new meters will be found to be well within the limit of good accuracy, inasmuch as they are carefully tested and adjusted at the factory before they are shipped. Before a meter is installed, however, its accuracy should be checked as a matter of record and in order to make any minor adjustments that may be found to be necessary. (In transporting a meter from place to place it is not at all unlikely that the finer adjustments may be affected.) When installing a meter care should be taken, as far as possible, to select an easily accessible place which is free from vibration, jar and moisture, and a place where it will be protected from the weather; it should be installed in such a position that it can be easily read—a point which is too often overlooked. The meter should not be roughly handled during installation or in carrying it from place to place, as it must be remembered that it is a delicate device and should be handled accordingly.

When putting a meter into service care should be taken to see that the moving element does not rest on the jewel bearing until it is installed and ready for operation. The different makes of meters have different methods of accomplishing this result, but in all of them provision is made for protecting the jewel bearing during transportation.

Before a service meter is put into operation it is necessary to see that it is level, since friction is liable to result if this precaution is not taken. (Some manufacturers furnish a small pocket spirit level for this purpose).

Meters should never be located beneath water pipes nor near steam pipes; they should be placed within 8 feet of the floor line so that the periodic testing may be accomplished with the greatest ease.

Meters should not be placed closer together than 15 inches between centers; if placed closer than this they may "interfere" with each other through the effects of stray fields.

Meters should not be installed close to conductors carrying heavy currents nor in the vicinity of iron girders or posts.

The subject of "over-metering" has already been mentioned in several places; as a general rule it may here be stated that for residence lighting the meter should have a capacity of approximately 50 per cent of the connected load; for small store lighting, window lighting, out-door multiple arc lamps, etc., the

meter should have a capacity of about 90 per cent to 100 per cent of the connected load, while for medium and large sized stores this percentage will be approximately 75 to 80 per cent. For metering a motor load, the meter should usually have a capacity of 100 per cent, except where a number of motors are installed, some of which may be running idle or lightly loaded most of the time, in which case a smaller meter could be used. Occasionally it is necessary to install a meter having a greater capacity than the connected motor load, as for instance in the case of hoists and high speed elevators.

A very convenient and reliable method of leveling meters without the use of a spirit-level consists of placing a coin, such as a quarter of a dollar, on the front of the disc and as near to the edge as possible; if the meter is out of "plumb," the disc will move so as to bring the coin toward the side which is the lowest. The meter can then be leveled so that the disc will remain stationary with the coin resting on the front edge; the coin should then be placed on the edge of the disc in a position ninety degrees from its former position, and the meter then leveled from front to back, without changing the previous adjustment. When the disc is perfectly level, the coin can be placed at any position around the edge, and the disc will remain stationary.

Is the Meter Properly Leveled .... *Fastened to Wall* ....
Is the Wall / or Partition { *Stone* .... *Wood* ....
Brick .... *Cement* ....

Does Location of Meter Subject it to { *Dampness* .... *Vibration* ....
Chemical Fumes .... *Damage* ....
Dust .... *External Magnetic Fields* ....

WIRING:
Old or New ....
Are House and Service Wires in Proper Meter Terminals ....
Permit Illegal Use of Current ....
(Evidence of S. C. on Meter Cover.)
Starts on .... *Polarity* ....
Creeping ....
Rate .... *Rev* .... *Min.* .... *Sec.*
Meter Left ....

Inspector's Report

Fig. 86.

Precaution should be taken to see that the meter is connected properly into the circuit, so that it will rotate in the right direction, especially is this true with polyphase meters, and with single phase meters when used to measure polyphase power. It is not infrequent that two single phase meters are used to measure the power being supplied to polyphase induction motors; the power factor of an induction motor when running lightly loaded is often below 50 per cent, in which case one of the two single phase meters will run backward when properly connected; care should therefore be taken to see that the meters are so connected that both of them will run forward, when the motor is operating at or near full load.

The card shown in Fig. 86, illustrates the form of "Inspector's Report" as used by the Pacific Gas & Electric Co., of San Francisco, Cal., the practice of having a report made out like this for all new installations is to be highly recommended.

(To be continued.)

ECONOMY OF STEAM POWER.

The economic wisdom of making the fullest possible use of an existing steam plant before branching out into gas engines, or purchasing electric current, will be readily admitted as a sound general principle. An example particularly worth noting, being an instance of steam on one side and a choice of gas or purchased current on the other, was recently reported on to a client by E. W. Dean, engineer, of Boston.

The elements of the problem were these: The heating of the hotel and warming of the hot-water supply were done by a steam plant consisting of two Babcock & Wilcox boilers, of 127 and 78 horsepower, respectively. For the water heating, there was a steel tank provided with a thermostatic valve which maintained a uniform temperature. There were also the necessary feed pumps. The condensation in the steam heating system was returned and used again in the boilers.

As to the generators, the requirement was that they should be able to carry the lighting load, start two of the elevators simultaneously, and operate the small motors. There were about 1800 16-c.p. lamps in the house, and the maximum lighting load, as settled by general hotel practice, was that required to operate the lamps, or 900, at one time—50 kw. The maximum electric power required was therefore:

For lighting	50 kw.
" starting two elevators, 50 h.p.	38 "
" operating three motors	6 "
	94 "

A 100-kw. generator, in duplicate, with a 35-kw. generator for use from midnight to some early hour in the forenoon, were recommended. The cost of a gas engine plant was estimated at a total of $27,400, this including $20,950 for three engines, and covering excavating, foundation work, piping, wiring, switchboard and incidentals. The annual cost of operation of gas engines was estimated at $9286, of which $4504 was required for gas used for power, and $3562 for fixed charges on the cost of the engine installation.

Three steam engines were estimated to cost $8408, the total expense of the engines, foundation, wiring, etc., being set at $13,500. The boiler plant and accessories ample in capacity for these engines, was already operating in the hotel. It was estimated that during eight months of the year the whole of the exhaust steam from steam engines could be used for heating feed water, wash water and radiators, and that the engines would be chargeable with consuming 2 lb. of coal per kw.-hour when the exhaust was so utilized; and 7.3 lb. per kw.-hour in the four months when the exhaust was not so used. On the basis of an estimated annual total of 197,586 kw.-hours, the annual coal consumption for the engines would be 372 tons, costing, at $4.34 per ton, $1614. The annual cost of steam power operation was set at a total of $4539, which included $1614 for coal, and $1755 for fixed charges. Comparative costs were summarized as follows:

Cost of installing gas engines	$27,400
Cost of installing steam engines	13,300
Annual cost of operating gas engines	9,286
Annual cost of operating steam engines	4,539
Probable cost of purchased current	8,126

A saving of about $3587 annually by the use of steam engines was demonstrated to be possible in this plant. Gas engines were shown to be more costly for operation than the purchase of current.

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POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Super-Heated Steam

The economy effected by the use of super-heated steam is always enticing in theory, but sometimes disappointing in practice. If the temperature of saturated steam be reduced by contact with the cooler walls of the engine cylinder some of it is condensed, thereby lowering the engine efficiency. This condensation may be diminished either by compounding or by using steam jackets, and may be eliminated by super-heating the steam as it leaves the boiler. Such super-heating gives an effective means of increasing the thermo-dynamic efficiency of the engine and the boiler, for it utilizes much heat in the waste gases that is otherwise lost.

The advantages of super-heating are so many and so manifest as to require no mention here. The disadvantages usually come to the surface only when the plant is incorrectly designed or incompetently operated. The chief difficulties experienced are in cylinder lubrication and in the failure of cast iron valves and fittings.

The first is a minor trouble which may usually be traced to the use of low-grade oils which are carbonized by the high temperature of the dry steam. Experience shows that it may be removed by using high-grade oil in an engine especially designed for super-heat operation.

The results of using super-heated steam with cast iron fittings have so frequently proven disastrous that a groundless fear has been implanted in the minds of many engineers. It is asserted that the crushing and crumbling of cast iron valves is due to the high temperature of the super-heated steam, which may reach 600 degrees. So firmly has this erroneous and illogical impression become fixed in the minds of some engineers that it is periodically necessary to bring the matter up for discussion, as was recently done before the American Society of Mechanical Engineers at Boston.

Saturated steam has been debited with many failures of cast iron. The concensus of expert opinion is that this is due not to the high temperature inherent in the steam, but to its extreme heat fluctuations. Under rapid expansion and contraction iron must ultimately wear out. By employing a super-heater designed to deliver steam at approximately constant temperature (a variation of 20 degrees is allowable) competent authorities agree that it is safe to heat the steam to 500 degrees. For higher temperatures open-hearth steel is recommended. English practice sanctions wrought material for all fittings, branches and valve chests distributing super-heated steam. While this is undoubtedly the safer course, it is believed that more trouble with cast iron has been caused by abuse than by use.

PERSONALS.

The Pacific Coast Jobbers' Association met at Del Monte, Cal., April 29, 1910.

George W. Roberts, an electrical supply dealer of Marysville, Cal., was a recent visitor in San Francisco.

R. D. Holabird, of the Holabird-Reynolds Company, of San Francisco, has returned from a trip to Seattle.

H. F. Keyes, manager of the Sacramento Natural Gas Company, was a San Francisco visitor during the past week.

F. E. Vickers, assistant engineer of the General Electric Company's San Francisco office, is making a short Eastern trip.

W. A. Hopkins, electrical engineer for the Safety Car Heating & Lighting Company, of St. Louis, is in San Francisco.

K. G. Dunn, engineer with Hunt, Mirk & Co., of San Francisco, has returned from a trip to Seattle and Puget Sound.

W. F. Lamme, consulting engineer with the Westinghouse Electric & Manufacturing Company's San Francisco office, is visiting Fresno.

W. L. Goodwin, sales manager of the Pacific States Electric Company, has returned to San Francisco from an extensive Eastern tour.

J. F. Turner was recently appointed superintendent of the Fresno., Cal., Traction Company, to succeed Mr. C. B. Jackson, resigned.

D. A. J. Bacon, of Ford, Bacon & Davis of New York, who is president of the Sierra & San Francisco Power Company, is in San Francisco.

Patrick Calhoun, president of the United Railroads of San Francisco, returned last week from an extended tour of the Eastern and Southern States.

Tracey E. Bibbins, assistant Pacific Coast manager of the General Electric Company, has sufficiently recovered from his recent illness as to resume his duties.

Thomas Mirk, of Hunt, Mirk & Co., representing the Westinghouse Machine Company on the Pacific Coast, returned last week from a visit to Southern California.

W. H. Leffingwell, of Bishop, Cal., who is engineer of the Mono Power Company spent the past week in San Francisco on business connected with the projected Owens River development.

C. R. Ray, manager of the Medford lighting plant, of the Rogue River Electric Company's system, has returned to Southern Oregon, after spending several days in San Francisco with his brother, Frank H. Ray.

N. K. Cooper, who was superintendent of distribution for the Independent Electric Light & Power Company and afterwards connected with the San Francisco Gas & Electric Company, has joined the sales force of the Westinghouse Electric & Manufacturing Company, with headquarters in San Francisco.

Will J. Sando has resigned as manager of the pumping engine and hydraulic turbine department of the Allis Chalmers Company, and, after taking a few months' rest, will open an office in Boston, as a consulting engineer. He will also be able to give personal attention to the interests of the Sando Engineering Company of that city.

F. O. Dolson, erecting engineer for the Pelton Water Wheel Company, is at La Grange, completing the installation of an 850 hp. Pelton-Francis turbine wheel, with Pelton governor, direct connected to a Westinghouse generator, for the La Grange Water & Power Company. The new wheel, which operates at 450 r.p.m., under a head of 220 feet, will feed into the Medosto and Turlock lines of the Mt. Whitney Power Company's system.

INSTITUTE MEETING IN SAN FRANCISCO.

The local committee in charge of the meeting of the American Institute of Electrical Engineers, which is to be held under the auspices of the High Tension Committee in San Francisco, May 5th, 6th and 7th, have made arrangements that insure a profitable and a pleasant gathering. In addition to Eastern officers, including President L. B. Stillwell, a full representation is expected from all the Western States.

The meetings will be open to visitors who are not members of the Institute and the interesting papers that have been prepared, together with the entertainment features that are contemplated, make this an auspicious time for electrical men to visit San Francisco. Headquarters will be maintained at the Home Telephone Company's building, 333 Grant avenue.

TRADE NOTES.

The United Iron Works of San Francisco and Oakland, Cal., have been appointed Pacific Coast representatives of The Kerr Turbine Company of Wellsville, N. Y.

Dearborn Drug & Chemical Works announces that after May 1, 1910, their general offices and laboratory will be on the twentieth floor of the McCormick building, Michigan avenue and Van Buren streets, Chicago.

The General Electric Company has sold to the Balakala Copper Mining Company, of Coran, Cal., two 40 hp. induction motors for use in the new installation for the prevention of injurious fumes at the company's smelter.

The General Electric Company has sold to the Northern California Power Company four 40,000 kw. 60 cycle static transformers, stepping up from 6,600 v. to 60,000 v. and the necessary switchboard equipment for one of the company's stations.

The Simpson Lumber Company, which is building a new lumber mill at North Bend, Ore., has awarded a contract for the entire power and mill equipment to Allis-Chalmers Company. The plant will be dziven by a 20 x 36 "Reliance" type heavy-duty belted Corliss engine.

The Canadian Westinghouse Company has been awarded the contract for a 1,000 kw. motor-generator set by the British Columbia Electric Railway Company of Victoria. The apparatus will be used for railway service in connection with the Jordan River Hydro-Electric transmission plant, now being installed by Sanderson & Porter.

John Hanbury of Vancouver, B. C., is building a new lumber mill, which will be of the modern Pacific Coast type and equipped throughout with electric drive. Allis-Chalmers Company has been awarded the contract for the entire equipment, including both sawmill and power machinery. A 500 kw., 480 volt, 3 phase, 60 cycle 3,600 r.p.m. steam turbo-generator will furnish power.

Two 715-h.p. Pelton-Francis turbines operating under 51-ft. head and running at 300 r.p.m., will be furnished to the Consumers' Power Co., Cannon Falls, Minn., each unit consisting of two spiral-encased Pelton-Francis wheels with central discharge draft elbow. Each turbine will be equipped with a 4-ton flywheel and a type "C" Pelton oil pressure piston type governor. An exciter water-wheel of 60-h.p. capacity, 600 r.p.m., is included in this contract; the exciter water-wheel also to be regulated by Pelton oil pressure governor. The Consumers' Power Co. has also placed contract with the Pelton Co. for two 1100-h.p. turbines of similar design to the above mentioned turbines and operating under the same condition, except that the flywheel will weigh about 6½ tons each, the exciter being of 90-h.p. This company carries on a general power and transmission business and provision for additional Pelton-Francis equipments is being made for their installation at a later date.

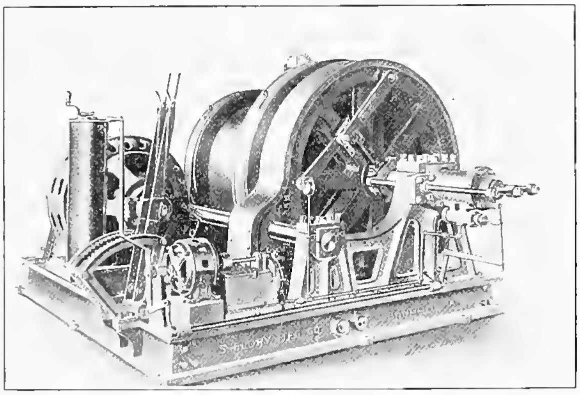
INDUSTRIAL

ELECTRIC MOTOR DRIVEN MINE HOISTS.

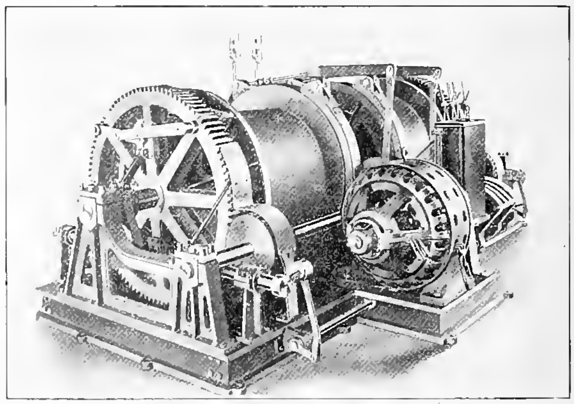
Since the cycle of operation in any hoisting proposition is of an intermittent character, the power required is at a maximum only a part of the time, even though the hoist be operated practically continuously. In many cases the hoist is in operation only a very small part of the day. These conditions offer special advautages from an economical point of view for the use of electric motor-driven hoists. The electric hoist is always ready, and uses power only in proportion to the load handled when it is in actual operation.

The bearings are self-oiling and the motors seldom require any other attention than an occasional inspection and cleaning. There are no complicated parts to get out of order or to require continual oiling, packing, etc. The electric hoist may be operated by almost anyone, as no previous experience or mechanical knowledge is required and an engineer's license is unnecessary.

The single and double drum electric motor-driven mine hoists of the S. Flory Manufacturing Company, Bangor, Pa., are well shown by the accompanying pictures. These hoists, which are especially designed for mines, quarries, planes, shafts, etc., are equipped with I. O. Werner patent hand friction and are driven by Westinghouse motors.



Single Drum Hoist.



Double Drum Hoist.

The patent band friction is of special design and possesses many features of superior merit. It is actuated through different members; the gear, drum, rocker shafts and strap bands. The strap bands tighten on a cast rim on the drums and are actuated by shafts which have double stub ends and are connected to the ends by jaw ends and turnbuckles. The lever arms are keyed to the rocker shafts on opposite ends and are actuated by the levers which move around fixed points on the gear. Slides are secured on the gear supporting the lever arms. The slides are actuated through a sleeve on the main drum shaft and two radial arms which are secured to the slides. The frictions are thrown in and out of contact by means of hand levers in a battery, as shown by the cut of the double drum hoist, or by an air cylinder using an equipment similar to street railway car air compressors, as shown by the picture of the single drum hoist. By moving the sleeve to the gear the slides are actuated in a radial direction that operates the stub levers and rocker shaft; this causes the band to grip or tighten on the brake flanges of the drums. The reverse motion of hte sleeve releases the friction. A strong claim is made for the gripping device. After the frictions are thrown into contact, they will positively remain in this position until released. The drum and gear form a unit and can be operated as a reverse motion hoist without producing any end strain on the bearings; the value of which is obvious. When the frictions are thrown out of contact, the drums are loose on the shaft and will revolve free at high speed when lowering or paying out the rope.

The single drum hoist is shown with a Westinghouse electric railway air compressor and air reservoir mounted on the base of the hoist. The reservoir is ocnnected to the air cylinder at the end of the drum shaft. The air valves are actuated by a lever shown close to the battery of two levers and controller. Very little exertion is required by the motorman to throw the friction in and out of contact as it is of the toggle type. After the air compressor is put on the contact continues until the friction is reversed by the reverse motion.

The drums are turned off smooth or machine spirally grooved for any size wire rope, and mounted on a self-contained cast-iron base arranged to receive the motor and controller. The drums for long planes or heavy lowering are equipped with asbestos brakes made out of long fibre material. The blocks are formed in sectors with iron flanges, securely bolted under high pressure, and treated with oil. They are secured between cast-iron flanges and surrounded with steel bands of the differential type. The brake bands are operated with hand levers in notched quadrants fitted with thumb latches, and are thereby securely held in any position. The advantage of asbestos brakes for long planes or shafts is decided.

The single-drum hoist shown by the photograph was installed at the Bliss Colliery of the D. L. & W. Company. The drum is 60 inches in diameter; 48 inches long between the flanges, and is designed for an 8,000 lb. rope strain at a speed of 500 ft. per minute. The hoist is operated by a Westinghouse type "HF" 150 hp. alternating current motor. This type of induction motor is especially suited for application where a strong starting effort is needed. It is well adapted for use on circuits carrying lighting loads, as the starting of it does not appreciably affect the voltage regulation. These motors are controlled by standard Westinghouse single handle, reversing, drum type controllers which insert resistance in the secondary at starting and gradually cut it out as the hoist speeds up; the controller has a large number of points that give smooth acceleration. When the controller is in the off position, the motor is entirely disconnected from the line.

The double-drum hoist shown was installed for the Bessemer Coal, Iron and Land Company, Messins, Ala. It is connected to a Westinghouse 125 hp. motor of the same type.

AN IMPROVED TYPE OF SPEED CONTROLLER.

Absolute reliability is a feature of the General Electric Company's CR 162 speed controller. Very often the control of shunt wound direct-current motors is accomplished by the use of two rheostats, one for starting the motor and the other for varying the motor field current for speed control. In the CR 162 speed controller these two rheostats are combined in one box and operated by the movements of one and the same rheostat arm.

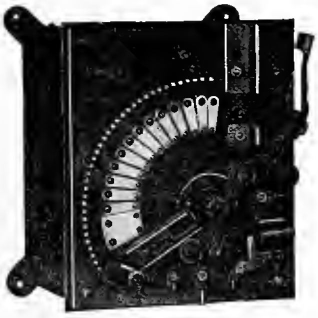


Fig. 1. Speed Controller. 35 hp. 115 Volts.

This device consists of a starting rheostat, the arm of which is provided with a projection carrying a sliding contact which moves over the contact buttons connected to the field resistance. An auxiliary arm on the right-hand side of the rheostat front serves to maintain a short circuit on the field resistance during the period of starting the motor, and on the starting resistance, when the arm is turned back to vary the running speed of the motor by regulating the field current.

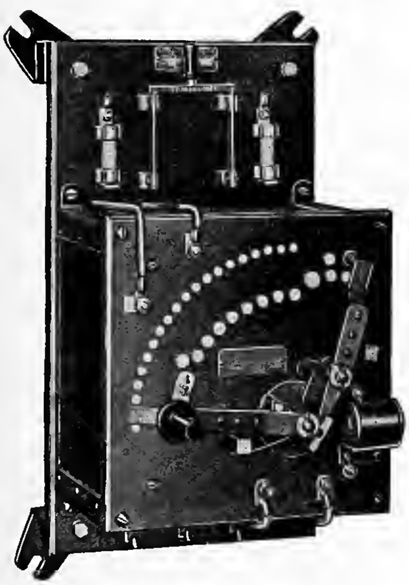


Fig. 2. CR 144 Speed Controlling Panel.

When starting the motor, the starting arm can not be left in any position on the contact buttons, due to the action of a spring, but must be turned to the right until it engages the auxiliary arm forcing the latter to be retained by the no voltage release coil. The auxiliary arm then withholds the spring actuating the starting arm and thereby makes it possible to leave the arm in any position on the field contacts, which will give the desired speed control of the motor. If the operator releases the rheostat arm at any position while it is being moved to the right during the starting period, it will immediately return to the off position. Upon failure of voltage the retaining coil is demagnetized, releasing the auxiliary arm, which in turn releases the spring which carries the starting arm to the off position, thus opening the motor circuit.

The rheostat is so designed that it requires a little extra pressure to move the arm beyond the maximum speed point, the object being to call the operator's attention to maximum speed position so that he will not unintentionally shut down the motor. When it is desired to stop the motor the switch-arm is thrown to the off position, deenergizing the retaining magnet and releasing the auxiliary arm which then opens the motor circuit. The maximum attainable speed variation is 3:1.

CR 163 starting and speed-controlling rheostats are the same as CR 162, with the addition of an over-load release coil. Either 162 or 163 controller can be supplied mounted on a slate base, together with a double-pole switch and fuses, and are then known as CR 144 universal speed controlling panels.

A NEW TELEPHONE MOUTHPIECE.

The ordinary composition or hard-rubber mouthpiece is easily broken and a source of considerable expense to a company in the course of a year. The ordinary steel mouthpiece removes this objection, but it is dangerous, as it is a ready conductor of electricity and source of danger during storms or through crossed wires. The common metal mouthpiece is affected by dampness and corrodes easily.

Taking these things into consideration, the Kellogg Switchboard & Supply Company has combined the advantages and eliminated the objections of the two styles, in the design of their new reinforced rubber covered steel mouthpiece. This mouthpiece has a perforated steel shell, covered with a coating of hard rubber, moulded over it at great pressure and heat. As the rubber is forced through the perforations and around the shell, it makes an absolutely unbreakable mouthpiece. The threaded portion is made directly on the steel at the base, eliminating danger of breakage at a point where most rubber and composition mouthpieces give way.

TELEPHONE DISPATCHING TRAINS IN THE NORTHWEST.

The Great Northern Railway, which at the present time is using the telephone to dispatch its trains on divisions covering approximately 2100 miles of its line, is now planning on a further extension of this system.

Orders have recently been placed for telephone train dispatching apparatus to be installed on six more divisions, viz.: Fergus Falls, Breckenridge, Northern, Dakota, Saint Cloud and Cascade divisions, covering a total of approximately 1,900 miles. As these divisions are among the most important and busiest of the whole railway—thirteen dispatchers being required to handle the large amount of traffic—it can easily be seen that this method of train dispatching has taken a firm hold upon the Great Northern Railway officials.

The apparatus to be installed will be the Cummings-Wray selectors and Western Electric telephones, as this style of equipment has been adopted as standard by this railway, and is now in use on the present circuits. Two hundred and ninety stations will be completely equipped for the new class of service.

An interesting feature of this installation will be the placing of telephones at sidings and at stations which are not open during the whole 24 hours—three hundred and fifty telephones being required. While the train crews in this way can reach the dispatcher at any time, the important fact is that the dispatcher can get in touch with the train crews waiting at any siding, thus enabling him to give orders, prevent congestion, and keep the traffic moving.

When the proposed equipment has been installed, the telephone train dispatching system of the Great Northern Railway will extend over the entire main line from Minneapolis and Superior to Seattle and Vancouver.

NEWS NOTES

INCORPORATIONS.

FRESNO, CAL.—The Modern Electric & Fixture Company has been incorporated, by H. H. Cartwright, W. F. Bledsoe and J. H. Blake, with a capital stock of $25,000.

LEWISBURG, ORE.—The Lewisburg Mutual Telephone Company has been incorporated, by E. Bowen, G. H. Thompson and W. J. Haberly, with a capital stock of $1,173.

MARYHILL, WASH.—The Maryhill & Goldendale Railway Company has been incorporated by S. Hill, H. C. Richardson and N. D. Miller, with a capital stock of $10,000.

LOS ANGELES, CAL.—The Fair Oaks Water Company has been incorporated by G. H. Chase, L. Wooster, P. A. Kilfoil, M. C. Fenn and others, with a capital stock of $75,000.

CALDWELL, IDA.—The Caldwell-Roswell Interurban Railway has been incorporated for $250,000 by H. W. Dorman, for the purpose of building the proposed electric line between this place and Roswell.

TACOMA, WASH.—The Sound Telephone Company of Pierce County has been incorporated with a capital of $5,000 by W. S. King, B. B. Sampson, A. M. McGoldrick, S. S. Watkinson and Edgart Wheeler.

PORT TOWNSEND, WASH.—E. A. Sims, of this place; Eric Molander, Everett; James H. Causten, James A. Calvert and Wm. B. Martin, Seattle, have incorporated the Olympic Power & Development Company, with a capital of $250,000, to supply Port Townsend and Irondale with electric power and water from the Dungeness, Quilcene and Dosewallips rivers; also to conduct an interurban car system between the two places.

TRANSPORTATION.

McMINNVILLE, ORE.—The Oregon Electric will lay tracks and build a depot at this place. Franchise having been granted.

WALLA WALLA, WASH.—It is announced that the Northwestern Corporation will build an interurban line between this place and Pasco.

RIVERSIDE, CAL.—An application from J. S. Jackson to construct a single track railroad for a term of 49 years in the County of Riverside, has been presented.

TACOMA, WASH.—Improvements under way for The Tacoma Railway and Power Company and the Puget Sound electric line this season will cost about $200,000.

SPRINGFIELD, ORE.—The City Council has accepted the bonds of the Lane County Asset Company to build the Willamette Valley electric line into this city within 24 months.

VANCOUVER, B. C.—J. W. Pike of this place has been awarded the contract for building the prairie section of the B. C. E. R. line on the Chilliwack extension, a distance of five miles.

GLOBE, ARIZ.—The Cananea Consolidated Copper Company is adding two 1,500 kw. horizontal Curtis turbines to the power plant at Smelter. They are remodeling the boiler plant and fitting it with Foster superheaters.

MARSHFIELD, ORE.—The officials of the Coos Bay Rapid Transit Company, recently organized to build an electric line from this place to North Bend, announce that work of building the line will be started as soon as franchises are secured in the two cities.

SAN FRANCISCO, CAL.—The Supervisors have passed the following resolution: "Directing the clerk of this board to advertise a notice for the sale of the Geary Street Railway bonds, issue of July 1, 1910, to the amount of $200,000, comprising thirteen bonds of each year's maturities, 1915 to 1934, inclusive. The sale is to be held May 16, 1910, at the hour of 3 o'clock p. m.

OAKLAND, CAL.—Grading for the new electric suburban system, which is to connect Contra Costa County with Oakland, was commenced last week at Walnut Creek. The road is known as the Oakland and Antioch Railway. The projectors plan to build it from Bay Point, through Concord, Walnut Creek, Lafayette, by way of the tunnel road, into Oakland. Fred Brooks, engineer in charge of the construction work, has announced that the plan is to complete the line this fall.

SACRAMENTO, CAL.—That construction work will be started by July 1st of this year, and that under favorable circumstances train service will be begun inside of a year is the prediction of Manager F. A. Warner of the Sacramento and Sierra Railway. The new railroad, which will be constructed from Sacramento to Lake Tahoe, primarily for the purpose of opening up a vast territory of rich timber land, and at the same time affording easy access to market of the products of Coloma, El Dorado County. There have been some delays in the last six months over obtaining the necessary rights of way, but only a few deeds are still unsigned. The exact route of the new railroad is as follows: From Sacramento the roadbed will run through Ben Ali, directly north of Sacramento, thence to Orangevale northeasterly, north to Rattlesnake Bar on the American River, thence to Pilot Hill and on to Cool, and thence directly east to Greenwood, Georgetown and so on to Jackson Spring and Lake Tahoe. The road will be a trifle more than 79 miles long. Running beyond Georgetown, the Sacramento and Sierra Railway will strike the vast timber belt of northern El Dorado County. One hundred and fifty thousand acres belonging to C. A. Smith, the lumber magnate, will be tributary to this road, and there are vast tracts which will thus have a direct communication with the markets by way of Sacramento. Manager Warner has called attention to the fact that a bid will be made for summer tourist travel to Lake Tahoe after the completion of the road.

TRANSMISSION.

LEWISTON, IDA.—The Kooskia Milling & Power Company will soon begin the work of repairing its dam, badly damaged by recent floods.

FOREST GROVE, ORE.—The Haines Power Company will extend its lines to Hillsboro. It will furnish light to the small towns between the two cities.

ILWACO, WASH.—The North Bend Light & Power Company has taken over the holdings of the Ilwaco Electric Light Company and will make many additions and improvements in same.

NELSON, B. C.—The International Electric Company, Ltd., with head offices here and with a capital of $1,000,000, has applied for incorporation to develop hydro-electric power from the falls at the junction of the Salmon & Pend d'Oreille rivers north of the boundary.

NORTH YAKIMA, WASH.—It is announced that when the Northwestern Light & Power Company and the Yakima Valley Power Company, the interests of Robert E. Strahorn,

are taken aver by the Northwestern Corporation, in the near future an extension of the transmission system will be made, connecting the Northwestern plant at Walla Walla with the power line at Pasco. Other improvements will be made.

REDDING, CAL.—The Northern California Power Company has brought a condemnation suit against Mr. and Mrs. D. L. Covey, of Whitmore, whereby it seeks to acquire 188 acres of land now held by the Coveys and which they refuse to sell at what the power company claims is a fair price. The Northern California Power Company, according to the complaint, purposes to make a storage reservoir of 1,540 acres on the Dry Burney Creek, eight miles from Kilarc, in a straight line. A dam 238 feet high will be built, and this will restrain water to a depth of 35 feet over this two and one-half square mile area, for the land is nearly level. By private purchase the company has acquired 1,352 acres from Thomas B. Walker, Edgar Firth, David Covey and L. B. Gordon.

ILLUMINATION.

ODESSA, WASH.—An electric lighting and power system is soon to be installed here, by the Washington Water Power Company.

ELLENSBURG, WASH.—A. E. Wright of Olympia has been granted a 50-year franchise to sell gas for illuminating and fuel pnrposes here.

SEATTLE, WASH.—The Seattle Lighting Company has filed plans for the construction of a $3,500 concrete foundation for a gas tank at 6350 Wellington avenue.

LOS ANGELES, CAL.—The Johnnie Mining and Milling Company, of which T. A. Johnson is manager, will install electric power and increase the capacity of its plant.

ELLENSBURG, WASH.—The City Council has granted A. E. Wright of Olympia a 50-year franchise to sell gas for illuminating and fuel purposes in the city of Ellensburg.

SPOKANE, WASH.—The Spokane Falls Gas Company will spend about $35,000 in enlarging its plant and laying new mains. A contract for improvements has been let.

CHICO, CAL.—An ordinance has been passed by the Board of Supervisors granting to W. H. Hanscom and J. H. Kimball a franchise for the right to erect and maintain poles for a power line.

RICHMOND, CAL.—H. B. Kinney, manager of the Richmond Light Power Company, has presented a petition asking that a franchise be granted to his company, allowing them to lay mains through the city.

SAN BERNARDINO, CAL.—The Victor-Virgin power plant, at Needles, which has not been in use for several years, is about to be put in shape to furnish power to mines and for other purposes, by C. H. Burlock of San Diego.

OLYMPIA, WASH.—The City Conncil has granted to H. H. Hyde a gas franchise for a period of 50 years, for the nse of streets and avenues for the purpose of constructing, maintaining and operating a plant and system for the manufacture and sale of gas.

GLOBE, ARIZ.—The Globe Light & Power Company is installing a 100 kw. General Electric generator direct connected to Williams Monogram engine. This is the first engine of the kind to be installed in the West. This company is adding 60,000 ft. holder two purifiers, exhauster and station meters to the gas plant at Globe.

LOS ANGELES, CAL.—The ornamental lighting of Seventh street from Hoover to Boyle streets, a distance of four miles, and to Sixth street, from Main to Alameda streets, has been approved by the Streets Committee. The property-owners have to pay for the ornamental post and for the electric current on the alternate years.

OAKLAND, CAL.—The erection of electroliers on Fourteenth street, between Castro and Market streets, and on Market, between Thirteenth and Fourteenth streets, has been recommended to the City Council by the Public Service Committee. Electroliers will also be erected along the length of Twenty-third avenue, from East Twelfth to East Twenty-third street.

LOS ANGELES, CAL.—Contracts have been let and pipe ordered for the building of the Domestic Gas Company's pipe line from Los Angeles to San Bernardino, and work will be started about July 1st. The line will run out through Boyle Heights and follow the line of the Pacific Electric Company to Covina. From there it will go direct to Pomona, and then on to Ontario and Uplands, supplying both of these towns with gas. From these it will take a direct shoot to San Bernardino.

SAN BERNARDINO, CAL.—The laying of the high-pressure gas mains for the San Bernardino Valley Gas Company will commence at once. As soon as the line to Colton is in commission the company will dismantle the Colton gas plant which is to serve the entire valley, Riverside and Corona, and the line now being built to supply Colton from here will be used in supplying San Bernardino from the central station. More than $500,000 will be expended in laying the system in the valley.

RICHMOND, CAL.—War has broken out between the Oakland Gas, Light and Heat Company and the Richmond Light and Power Company. The struggle follows the failure of negotiations when H. B. Kinney, manager of the Richmond company started to buy gas at wholesale from the Oakland corporation. Kinney's offer was not accepted. Thereupon he announced that his company would build a plant and go into the gas business. The rate charged by the Oakland company has been $1.50 a 1,000 cubic feet, as fixed by the City Council. Kinney says that he will spend $200,000 in installing a gas manufacturing plant.

SANTA BARBARA, CAL.—One of California's new laws may have an early opportunity to be tried in Santa Barbara. The Council, in meeting to decide npon an increased gas rate, was informed by E. D. Berri that the referendum would not be long in following the decision of the Council in increasing the gas rate of the Santa Barbara Gas and Electric Company (Edison) from $1 to $1.25. The meeting was attended by a number of citizens all protesting against the proposed rate. The Council extricated itself by resolving that this rate should he made only after the company has spent $100,000 in improving the plant and when a first-class pure gas of even pressure is being manufactured. The main object of attack was the report of Prof. C. L. Cory, a San Francisco gas expert, who was brought here by the Council to determine the value of the plant so that a rate could be placed by which a fair return could be had by the company. Cory's report was favorable to the company.

TELEPHONE AND TELEGRAPH.

EVERETT, WASH.—The City Council has started a move to have telephone wires put underground in the city.

DAVENPORT, WASH.—Telephone franchises have been granted to J. M. Palmer over certain roads from Lamona and Odessa.

DILLON, MONT.—The Southern Montana Telephone Company has decided to increase its capital stock from $10,000 to $40,000 and will make numerous extensions.

NAPA, CAL.—It has been ordered that C. A. Henne be granted permission to install a telephone line from St. Helena Sanitarium to his place, commonly known as the "White Cottage."

INDEX TO ADVERTISEMENTS

JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

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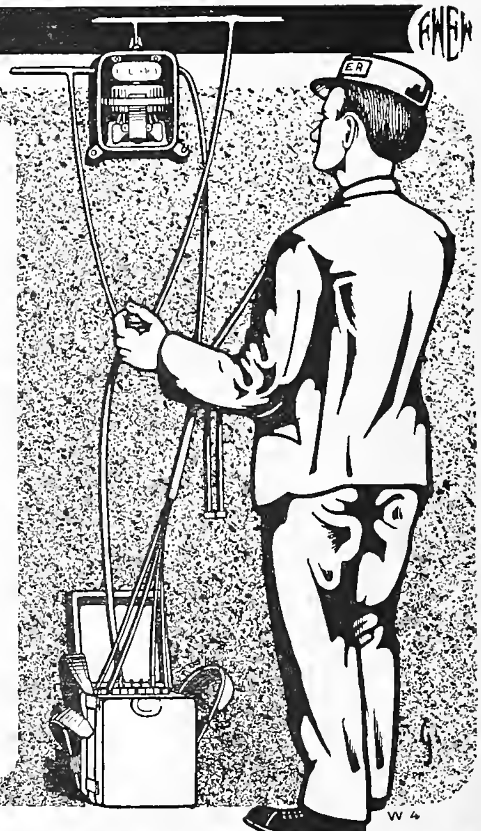

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TO

Place.	Population.
Agua Caliente	50
*Alameda	27,000
**Albany	800
†Alta	200
Alvarado	200
Amador	200
Antioch	3,000
†Auburn	2,050
Barber	200
** Belmont	600
Belvedere	350
Benicia	2,500
**Berkeley	42,000
Big Oak Flat	150
Biggs	750
Black Diamond	500
Brentwood	200
Brighton	100
Broderick	500
‡Brown's Valley	50
**Burlingame	5,000
Byron	200
Campbell	1,000
Cement	1,500
‡Centerville	20
Centerville	500
**Chico	13,000
**Colusa	2,700
‡Colfax	400
Colma	500
Concord	1,500
Cordelia	150
Corte Madera	350
Crockett	2,500
Crow's Landing	375
Davenport	1,000
Davis	750
Decoto	350
Dixon	1,000
Dobbins	50
Drytown	100
Durham	500
‡Dutch Flat	400
**Easton	500
**East San Jose	1,500
Eckley	20
Emerald	50
Elmhurst	2,500
Elmira	150
El Verano	100
**Emeryville	2,000
Encinal	20
Fairfield	800
** Fair Oaks	250
Fitchburg	250
Folsom	1,500
*Fresno	35,000
Glenn Ellen	500
Gold Run	100
Grafton	350
†Grass Valley	7,000
Gridley	1,800
Groveland	50
Hammonton	500
Hayward	4,000
Hollister	3,000
Ione	900
Irvington	1,000
Jackson	2,000
Jackson Gate	50
Larkspur	950
Lawrence	100
Kennedy Flat	50
Kentfield	200
‡Lincoln	1,500
‡Live Oak	200
Livermore	2,250
‡Loomis	150
Los Altos	200
Los Gatos	3,000
Mare Island	500
Martell	25
Martinez	5,000
**Marysville	6,250
Mayfield	1,500
**Menlo Park	1,500
Meridian	300
**Milbrae	300
Mill Valley	4,500
Mission San Jose	500
Mokelumne Hill	150
Mountain View	2,500
**Napa	6,000
†Nevada City	4,000
Newark	700
‡Newcastle	600
New Chicago	25
Newman	1,000
Niles	800
**Oakland	230,000
Oroville	2,500
Orwood	50
Pacheco	200
**Palo Alto	6,000
‡Penryn	250
Perkins	200
**Petaluma	6,000
Peyton	250
**Piedmont	2,000
Pinole	1,500
Pleasanton	2,000
Port Costa	600
**Redwood City	3,500
Richmond	10,000
Rio Vista	200
‡Rocklin	1,050
Rodeo	100
‡Roseville	345
Ross	900
***Sacramento	52,000
San Andreas	200
San Anselmo	2,500
San Bruno	1,500
San Carlos	100
**San Francisco	450,000
**San Jose	40,000
San Leandro	4,000
San Lorenzo	100
**San Mateo	7,000
San Pablo	1,000
**San Quentin Prison	1,600
**San Rafael	6,000
Santa Clara	8,000
Santa Cruz	10,000
**Santa Rosa	8,000
Saratoga	200
Sausalito	3,000
Sebastopol	2,000
Selby	100
Sonoma	1,200
South San Fran.	2,500
Stanford Univ.	2,000
Stege	100
‡Stockton	25,000
Suisun	1,200
Sunnyvale	2,000
Sutter Creek	2,000
Tiburon	100
Tormey	150
‡Towle	200
Tracy	1,200
Vacaville	2,500
**Vallejo	12,000
Vallejo Junction	10
Walnut Creek	350
Wheatland	1,400
Winters	1,[illegible]00
**Woodland	3,500
Yolo	350
**Yuba City	1,900

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JOURNAL OF ELECTRICITY
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THE DEVELOPED HIGH-TENSION NET-WORK OF A GENERAL POWER SYSTEM[1]

BY PAUL M. DOWNING.

The greatest incentive to the development and construction of hydroelectric transmission systems has been high fuel costs. This is particularly true in California, where, until the discovery of oil a few years ago, practically every industry using steam as a motive power had to depend on coal imported from Australia or British Columbia.

The 4427 ft. Span of the Pacific Gas & Electric Co. Across Carquinez Straits.

Owing, however, to the natural advantages due to the topography of the country, the possibilities of utilizing the waters for hydroelectric development were early recognized, and probably more has been done along pioneer lines in this State than anywhere else.

In the preparation of a paper on this subject, therefore, I have confined myself entirely to conditions as they have developed and as they exist in California at the present time, and to the experiences in connection with the different transmission systems, which together form probably the greatest mileage of high-tension net-work to be found anywhere in the world.

On account of the rapidly growing demand for powe , it was not possible to wait for results, which, under ordinary conditions could have been obtained from actual operation, but, under the circumstances, things have been done which very conclusively confirm a statement made by Mr. Charles F. Scott in his paper on "Electrical Power Transmission," read before the International Electric Congress held in St. Louis in 1904, wherein he states that problems of transmission are not problems that can be solved in the laboratory alone, but the apparatus must meet the precise conditions of operation and be judged by experience.

The first polyphase high-voltage transmission system in the world was the one from Mill Creek to Redlands, a distance of 16 miles. The original installation consisted of three 250-kw. three-phase generators delivering 2400 volts at their terminals, and seven 100-kw. transformers stepping up from 2400 volts to 11,000 volts at which potential power was transmitted to Redlands. The unqualified success of this undertaking almost from its very inception, gave a great impetus to the industry, and within a very few years other installations were made, each with its particular type of apparatus and character of construction.

The Colgate power house of the Pacific Gas & Electric Co. was really the nucleus of the present 60,000-volt net-work, in that it was the first to install

[1]Paper presented at the San Francisco meeting of the American Institute of Electrical Engineers, May 5, 1910.

Map of High-Tension Transmission Lines and Power Plants in Central California.

(4) Northern California Power Co.
(5) Oro Water, Light & Power Co.
(6) Pacific Gas & Electric Co.
(7) Great Western Power Co.
(9) Snow Mountain Water & Power Co.
(11) Sierra & San Francisco Power Co.

apparatus to operate at that voltage, and it was, at the time, the largest and most important hydroelectric station in this part of the State. The history of this plant is unique, in that the generators were installed, in operation, and overloaded, before the construction work on the building was completed.

The system of the Pacific Gas & Electric Co. as it stands today represents the consolidation of a number of smaller companies, each with a system peculiar to itself, and none of them designed with a view of ever tying in with any other system. As a result, almost every type of apparatus from the comparatively small, low-voltage, rotating-armature generators, to the larger, more modern, rotating-field, high-speed machines, is represented.

This company controls and operates eleven different hydroelectric generating stations, having an aggregate capacity of 64,270 kw., distributed as follows:

Power house	Capacity in kilowatts	Generator voltage
De Sabla	13,000	2300
Centerville	6,400	2300
Colgate	13,700	2300
Yuba	600	2300
Alta	2,000	500
Auburn	350	500
Newcastle	900	500
Folsom	3,250	800
Electra	20,000	[illegible]
Deer Creek	5,000	
Nevada	1,200	5500

Ten of these have a common frequency of 60 cycles and run in parallel on a 60,000-volt net-work which is also supplied with additional power from four independent companies.

The Great Western Power Co. delivers 60,000 volts by stepping down from its main line voltage of 100,000; the Sierra and San Francisco Power Co., the Northern California Power Co., and the Snow Mountain Power Co., deliver current at 60,000 volts direct

At times, the load carried by these four companies amounts to an aggregate of 41,500 kw. In addition to the foregoing, we have the following reserve steam and gas engine plants which operate in parallel with the transmission lines when occasion requires; viz., Oakland steam turbine station, San Jose steam station, and Martin gas engine station.

The total reserve capacity at these three stations amounts to 21,500 kw. In Martin station are located two 4,000-kw. frequency changers (from 60 to 25 cycles) which are operated from the transmission line. The 25-cycle side is run in parallel with the 25-cycle gas engine-driven units, and also with the 25-cycle steam-driven station of the United Railroads.

The entire mileage of lines represented by the different systems which are tied together, exclusive of those of 11,000 volts and under, amounts to 1,920 miles.

The voltages of the different lines making up the net-work are as follows:

150 miles of 100,000-volt line.
1,390 miles of 60,000-volt line.
380 miles of 20,000-volt line.

It will be noted that lines of 11,000 volts and under are not included in the above for the reason that these lower voltage lines are considered as distributing lines and not as transmission lines.

The paralleling of stations in this manner, regardless of the length of line between them, or the loads carried, has not developed any difficulties, but on the contrary, it has been found that it could be done much more readily than where the generators are paralleled in the same station; nor is it customary to do this paralleling at generating stations alone, or on the low-voltage side of sub-stations. As a matter of fact, it is done almost entirely on the 60,000-volt side, using transformers of relatively small capacity connected from line to ground for synchronizing purposes.

The governing and the division of load between the different stations furnishing power to a system of this kind is not as great a problem as it would at first appear. Each station, excepting one, takes its alloted portion of load and makes no attempt whatever to govern, unless the frequency varies beyond certain predetermined limits, the speed control being left entirely to a single station. All important power houses are equipped with governors, which, except in the case of the governing station, are set so that they will be sluggish in their action, and will not operate except on wide variations of speed. Those in the governing station should obviously be adjusted to regulate as closely as possible. The governing is not limited to any one particular station, but it can be done at any station having sufficient capacity to handle the fluctuations of load.

In order to operate as we do, with a large number of stations running together, we found it necessary to have a chief operator, or what we have seen fit to call a "load dispatcher," who, so far as the details of operation are concerned, is in absolute charge of the entire system. Water cannot be taken out of a ditch or flume, a power house superintendent or foreman cannot shut down a generator or change the load carried on the station, and a line crew cannot work on a line, without first having the approval of the load dispatcher's office. He is at all times in direct telephone communication with every part of the system, and in the event of trouble which might interrupt service, has absolute control of all matters in connection with the re-establishing of service. In his office there is a board showing diagramatically every generating station, transmission line and sub-station on the system, together with dummy switches representing every air and oil switch, and the exact position of these switches, that is, whether open or closed. In addition to the record as shown by the board, a complete log is kept of every detail in connection with troubles of any kind, loads carried by the different stations, and any other matters pertaining to operation.

Telephone circuits are run on all transmission lines, but these are not depended upon for anything more than local use, such as for linemen reporting on and off the line, etc. They do not give satisfactory service when used over long distances, and they become inoperative when there is trouble on the line and when they are most needed.

For communicating between important stations we have circuits leased from the telephone company, which run on its regular toll line leads, and being over entirely different routes are not affected to any extent by transmission troubles.

Method of Operation.

As stated above, the different stations are, for the greater part of the time, operated in parallel. There

are two distinct advantages in operating in this manner:

1. The regulation of voltage is much more readily accomplished.

2. The capacities of the different stations can be utilized to their fullest extent.

On the other hand, there is a distinct disadvantage, as trouble on any part of the system will, to a certain extent, affect the entire system.

The inductive drop on the long lines forming a net-work of this kind is obviously high, especially where the induction motor load is heavy, and the power factor correspondingly low. The synchronous motor load represents a very small percentage of the entire load, and there is little opportunity to over-excite the fields and use them as boosters. The watt-less current, therefore, becomes quite a problem, and has to be taken care of either by distributing it among the different power houses, or by taking it entirely on a single station, which can be handled very readily by proper adjustment of generator fields.

From an operating standpoint, and in order to better guarantee continuity of service to the more important districts, a reserve steam plant is very essential, and in this respect the modern steam turbine serves the purpose admirably. By reason of the fact that it operates equally well at all loads it can be connected in parallel wtih the transmission line, and under normal conditions will carry a good portion of the wattless current. At the same time it acts as a stand-by, and in case of line trouble it can pick up the load on very short notice.

Troubles on the long lines forming net-works such as this do not always seriously affect the entire system, but show only as momentary drops in voltage. The station generators are connected directly to the line, without circuit-breaking devices of any kind, and power is never cut off the lines unless it is impossible to keep it on. Immediately on the slightest indication of line trouble, the system is separated, leaving different sections or districts supplied from different sources. If the trouble is far enough removed from the generating station it will not be very severe on account of the inductive and ohmic drop of the intervening lines, and generally the operators will have time to separate the sections without more than a temporary drop in voltage. If, however, the trouble is near a power house, that particular station will be thrown out of synchronism with the system, and even the machines in that station may be thrown out of synchronism with each other.

Connection.

The greater number of the lines feeding into the system are supplied with transformers delta connected on the low-tension side and star connected on the high-tension side, with the neutral grounded.

This arrangement has proved very satisfactory, and while it might be said that there is a disadvantage in using such a connection on account of the grounding of one wire throwing a short-circuit on the system, yet there is a question as to whether or not this is a real disadvantage.

If all lines could be run through sparsely settled districts, or where there would be little liability of damage to persons or property were a wire to come down, there would, doubtless, be some advantage in operating with a delta connection, but where lines are run along public highways and through more or less thickly settled districts, it seems almost necessary that there should be some very positive indication to show when a wire goes down.

Some objection has at different times been raised by the telegraph and telephone companies to a grounded neutral system, on account of the inductive influences due to current through the ground, at times when the load is unbalanced. Experience, however, has shown that this is not the real cause of the trouble, but that the troubles these companies have are the result of what might be called static unbalance, or high-frequency disturbances due to arcing grounds, or other causes which occur to a greater extent in an underground system than in one where the neutral is grounded, and therefore at zero potential. This statement is borne out by experiments that have been made on telephone circuits paralleling or carried upon the same poles as the transmission wires, where loads aggregating as high as 3,000 kw. have been transferred from three to two transformers of a bank, or vice versa, with practically no effect on the telephone service other than slight change in the tone of the line.

Our usual practice is, where one of three transformers in a bank at the generating end is out of service, to carry load up to the capacity of the other two, or should occasion demand, to overload the two, making them carry the normal load of the three. It is not necessary to limit the unbalancing of power delivered to the line in this manner, and we would have no more hesitation in cutting out one of a bank of three 1500-kw. transformers than in cutting out one from a bank of three 100-kw. transformers. This same condition obtains in the case of step-down transformers. When the load to be supplied is small, and where the expense of installing three, or even two, transformers to give a three-phase distribution would not be justified it is customary to install a single transformer, connecting it from the line wire to ground. Installations of this kind ordinarily give no trouble whatever, but work as satisfactorily as though a bank of three were installed. Careful attention must always be given to the ground connection. These are made by connecting to the water mains, and also to ground plates buried to a depth depending on the character of the soil.

Occasionally it has been found where only a single transformer is used, that a severe static stress occurs on the low-tension side, which is severe enough to puncture the insulation of the lower voltage transformers supplied from the main transformer. These instances, however, have been comparatively few, and while it is something which might be expected from a connection of this kind, it very seldom occurs, and it has never been serious enough to make it necessary to abandon the practice.

The connection on the low-tension side of the step-down transformers is either delta or Y, depending entirely on the particular voltage condition to be met. Where the Y connection is used, the neutral is grounded in the same manner as on the high-tension side, and to the same ground wire.

So far as the actual operation of the system is

concerned, there is no preference as to the connection on the low side, but for economic reasons the greater number of low-tension distributing systems are supplied from the Y-connected transformer. We have never yet had any troubles which we could trace back and find to be the result of the manner in which transformers were connected.

Transformers.

The capacities of transformers used, range from 100 to 1500 kw. Most of them, except some of the smaller sizes, are shell type, oil-insulated, and water-cooled. The most satisfactory case for oil-cooled transformers is one of boiler iron mounted on a cast iron base and having a cast iron top.

A great deal of discussion has been heard concerning the merits of the different insulating materials used in transformers for high-voltage work, the kind of oil to be used, and the methods of cooling the oil. During the past few years the tendency of the transformer manufacturers has been toward the use of a press board or horn fibre for the insulating barriers between the coils, this material being used to replace the micanite used in the earlier transformers. This gives a transformer of lower first cost but one correspondingly less staunch and reliable.

The micanite insulation has two distinct advantages; first, it will not absorb moisture as readily as the pressboard or horn fibre; and second, being non-inflammable, it will localize trouble, and a burn-out in one coil, unless it be exceptionally bad, will not damage adjacent coils. Until a few years ago all of the transformers on the system had micanite insulation. They would be received from the factory, and without attempting to dry them out, they would be filled with oil and put into service. The oil was generally shipped in iron drums containing from 50 to 100 gallons, and when received, it would be put into the transformer without treatment of any kind, and even without being tested to see that it had the proper dielectric strength. The pressboard has superseded the micanite, and the methods of handling transformers have entirely changed. We now find it necessary to dry them out thoroughly even after they have been standing without oil for not more than ten days or two weeks. The oil also is being handled much more carefully than formerly, and separate samples taken from the different tanks in which it is shipped, must be tested. If the dielectric strength is found to fall below a certain standard, it is safe to assume that the low insulating qualities are due to moisture, which can be readily removed by heating to a temperature slightly above 212 degrees Fahr.

The pressboard or horn fibre will not only absorb moisture from the atmosphere, but it will, when in direct contact with water, absorb sufficient of it to allow the layers of fibre making up the sheet, to separate, thus rendering it worthless. This objection to its use might on first thought seem hardly worth considering, but in practice it is an important one. In handling transformers out of doors during stormy weather, or in the event of a damaged water coil allowing water to get into the winding, the pressboard would be damaged to such an extent that the transformer would have to be torn down and the barriers replaced.

As to the relative fire risks of air and oil-cooled transformers, I think that it is now generally conceded that the oil type with a properly designed case is the safer of the two.

The greatest danger from an oil-insulated transformer is from fire external to the transformer itself, which might damage the case and allow the oil to escape.

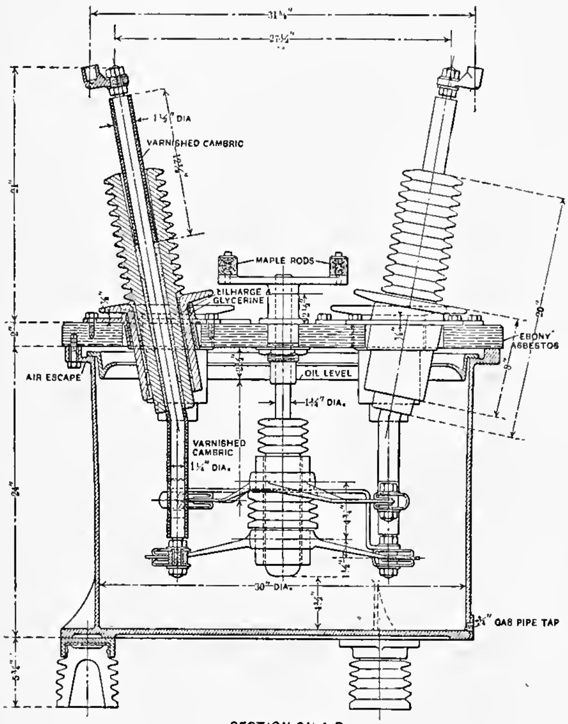
In a number of instances there have occurred fires which have heated the boiler iron cases to such an extent that the oil has been badly carbonized and the paint on the inside of the case burned entirely off witho't damage being done to the winding. After removing the damaged oil and cleaning the winding, the transformers have been refilled with new oil and immediately put back into service without trouble. In one particular instance which I have in mind, a fire occurred in a wooden switch gallery almost directly over a bank of 700-kw. transformers which at the time were not in service. Before water could be turned on the fire the transformers had become very hot, and when water was finally turned on, the cast iron tops had become so hot that the water coming in contact with them, damaged them beyond repair. The windings of the transformers were uninjured, and after being dried out were put back into service and are operating today.

From the viewpiont of the man who has to operate the transformer, particularly in connection with long high-voltage lines, I am inclined to question the advisability of attempting to sacrifice the reliability of the transformer in order to cut down the first cost. In the absence of any approved device or apparatus that can be relied upon to take care of high-voltage line disturbances, the transformer must bear this burden to a very great extent, and the breaking down of a transformer with the resulting interruption to service, will, in a very short time, more than offset any saving in first cost. For this same reason the three-phase transformer is at a disadvantage, as trouble on one phase would entirely interrupt service, unless a spare were installed.

For cooling the oil we employ the usual method of circulating water through copper coils immersed in oil. Different metals have been used in these coils, but on account of there being less liability of copper being acted upon by acids in the cooling water, and also because of the fact that it will not corrode, it has been found most satisfactory. In localities where there is any great amount of mineral in the water, a cooling coil will in time become filled to such an extent that it will not carry a sufficient amount of water to cool the transformer. This deposit closely resembles boiler scale, and in some instances it can be removed by taking the coil out of the case and hammering it on the outside to loosen the scale, after which it can be blown out by either steam or compressed air. In cases where it cannot be removed in this way, we have used dilute muriatic acid as a last resort, but as this acts upon the metal of the coil, as well as upon the scale, it cannot be considered entirely satisfactory.

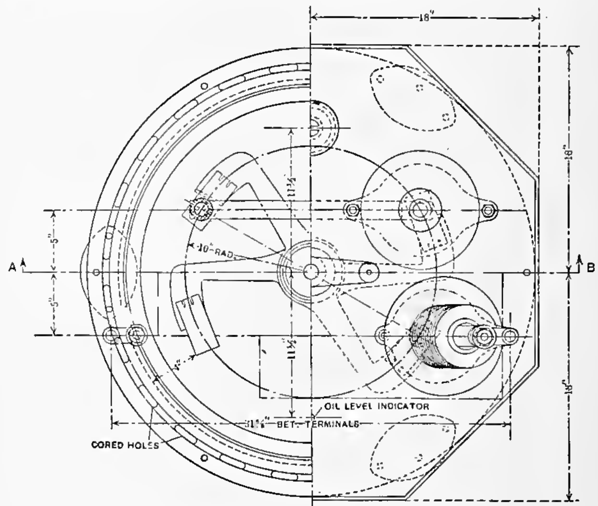
Periodic pressure tests are made on all cooling coils without removing them from the transformers, and very often without taking voltage off the transformer. This we do by disconnecting both ends of the

coil and allowing the water in the lower turns to either drain off; or, if both ends of the coil come up over the case, a small rubber hose is inserted on the riser side of the coil and the water syphoned out. To know that the coil is thoroughly dry, and that in the event of its breaking down under pressure, no water will get into the transformer winding, a light blast of air is passed through the coil, which, with the heat from the oil on the outside of the coil, will in a very short time remove any moisture which might remain. One end of the coil is then plugged and air pressure applied by means of an ordinary automobile tire pump. A small pressure gauge connected to the coil shows the pressure on the coil ,and also whether or not there are any leaks which would allow the pressure to drop. Generally where there is no back pressure on the coils, 15 to 25 lbs. will be as high a test as is necessary.



SECTION ON A-B

Fig. 1. Elevation of High-Tension Switch.



TOP REMOVED | PLAN VIEW

Fig. 2. Plan of High-Tension Switch.

Switches.

Outside of the lightning arrester or line discharger for taking care of high voltages, high-tension switches were probably slower to develop than any other piece of apparatus used in connection with long transmission lines. It is only during the past few years that there have been any high-tension switches on the market, but there are now a number of different designs, all of which have proved generally satisfactory.

The system of the Pacific Gas & Electric Co. was one of the first to use oil switches for voltages in excess of 40,000. As early as 1900 we built and put into operation, switches which were of practically the same type that we are now using. While the switch was in the experimental stages, the framework supporting the tanks were of wood, and the tanks themselves were the ordinary fibre or paper mache tubs such as are used for laundry purposes. Switches of this kind served their purpose well, and are even now in use after years of service, but where they are called upon to break heavy loads, such as come on at times of short-circuit, they are apt to throw the oil out of the container when operated.

To overcome this trouble, we designed a four-break switch, along practically the same lines, but with a considerably greater depth of oil over the contacts. Four-break switches similar to the one shown in Figs. 1 and 2, have been in service in some of our largest power houses for several years, and they have never failed to open the line under all conditions of short-circuit.

The particular features which recommend this switch are:

1. The absence of any insulating material that might become saturated with oil and catch fire either from leakage or from an arc.

2. The insulation of the switch from the ground, thereby affording the greatest protection against breakdowns due to surges or other high-voltage disturbances when the switch is open.

3. A constant depth of oil over the contacts at all positions of the blades.

4. The comparatively small amount of space taken up by the switch.

We have never attempted to operate any of these high-tension switches either automatically or by any electric or pneumatic means, preferring rather to keep to the more positive hand-lever control. This control has generally proven quite satisfactory, but we have just installed some reverse current relays to be used in connection with the automatic operation of switches on lines which are tied together at both ends. We have yet to learn to just what extent these can be successfully employed, on account of the inherent weakness of alternating-current reverse-current relays, whose operation is dependent on both current and voltage, and the fact that in cases of severe trouble the voltage may drop so low that the relay will be inoperative.

Lightning Arresters.

Except in the higher mountain districts the Pacific Coast is comparatively free from lightning, and we

make no attempt whatever to protect against lightning disturbances.

On most of the early installations, lightning arrester apparatus, such as was on the market at the time, was installed at different points along the line. Practically every type of multigap arrester was tried, all of which proved to be a menace rather than a protection on account of their arcing over whenever there was a heavy line disturbance. The result has been that long since they have been abandoned, and we now use only the horn-gap type arresters with the air-gap set so that they will arc across on voltages approximately 25 per cent above normal. The particular design of arrester used, consists of two gaps in series with the ground side, connected directly to earth without resistance.

These are used more on account of their being voltage limiting devices than on account of their being a protection against high voltages. Discharges over these arresters always cause a drop in voltage, and very often a momentary interruption to service until the arc breaks. We do not install them at every station, but only at the power houses and more important stations where heavy switching is done. The electrolytic arrester now on the market has been installed on some of the lines in this State, but as they have been in service only a short time, little can as yet be said concerning their efficiency or effectiveness.

Insulators.

The question of line insulation for the high voltages now being used on transmission lines, is the most serious problem engineers have to face, and while it is true that both the design and quality of the insulators manufactured today are far superior to those of a few years ago, it is also true that the limiting voltage of a transmission system is governed by the insulators.

The climatic conditions of the greater part of the Pacific Coast are peculiar in that there are two seasons, one wet and one dry; and it may seem strange to say that the insulator trouble during the dry season, or just when the first rains start in, is as much as or more than there is during the winter storms. The trouble is due to leakage over the surface of the insulator on account of the dirt and the salt which is deposited by the ocean fogs. As soon as the heavy rains come, this accumulation of dirt, etc., is washed off, and the number of insulator troubles is materially reduced. The number of insulators that actually puncture are very few, the greatest trouble being due to leakage. As a striking illustration of troubles of this kind, I might state that insulators operating successfully at 60,000 volts in the mountain districts outside of the fog belt, and where there is little or no dust, give a great deal of trouble on 11,000-volt lines in the bay district where they are exposed to more severe conditions of dust, fog and smoke.

Troubles of this kind generally affect insulators on grounded and ungrounded structures differently. If they are supported on poles where the leakage path to ground is a high resistance one, the top of the pole will be burned off, and generally the insulator is not damaged. But where metallic structures or grounded pins are used, thus giving a low-resistance leakage path to ground, the insulator is more often damaged by the arc, which very often is great enough to burn off the line wire.

Troubles of this kind naturally bring up the question of what design of insulator will best meet the conditions, and whether or not the theory that as much of the insulator as possible should be kept dry is a correct one. This theory has been carried out in the vertical or pin type insulator with the result that in the three and four-part insulators a good portion of the inner petticoat is protected from the rain and cannot be washed by the elements. It therefore becomes necessary to shut down the line and wipe them by hand. This cleaning is especially necessary in the fog district near the bay and along the coast, where it has to be done about twice each year. The suspension insulator has a decided advantage in this respect, in that a much greater part of the surface of the insulator is exposed to the rain and dirt, and is washed off during stormy weather. However, with the higher voltages at which this type of insulator is designed to be operated, there is every reason to think that similar troubles will be experienced, and doubtless the same homely means will sooner or later be resorted to in order to overcome it.

THE MEXICO LIGHT & POWER COMPANY'S ELECTRIC PLANT.

BY H. E. WEST.

The following interesting description of an electric plant in Mexico is reprinted from a recent issue of The Mining World of Chicago by the courtesy of whose editor the accompanying illustrations were supplied:

Necaxa is a well known name to all who dwell in the Federal District of Mexico and bordering States. Until a few years since it was noted as the site of one of Mexico's greatest water falls. Within the last 7 or 8 years it has carried especial interest as being one of the largest, if not the largest, generators of electrical energy in Mexico.

The Mexico Light & Power Co. has during these years been installing a plant, that, starting with modest proportions, has now assumed a stupendous scale. It is a Canadian enterprise, under the leadership of Dr. Pearson, closely allied to the interests which have recently concluded the San Paolo tramway and light plant in Brazil.

Practically the identical engineering staff, which successfully carried out the Brazilian enterprise, is now engaged on the construction of the Necaxa plant.

Power for the last four years has been furnished to Mexico City, operating there the tramways, manufacturing mills, and municipal street and house lighting. From 10,000 to 12,000 hp. has been utilized at El Oro, 175 miles distant, for operating mining machinery, mills and for lighting. To large consumers the charge is $50 gold per hp. year. The mines of Pachuca will soon be able to utilize this cheap and constant source of energy.

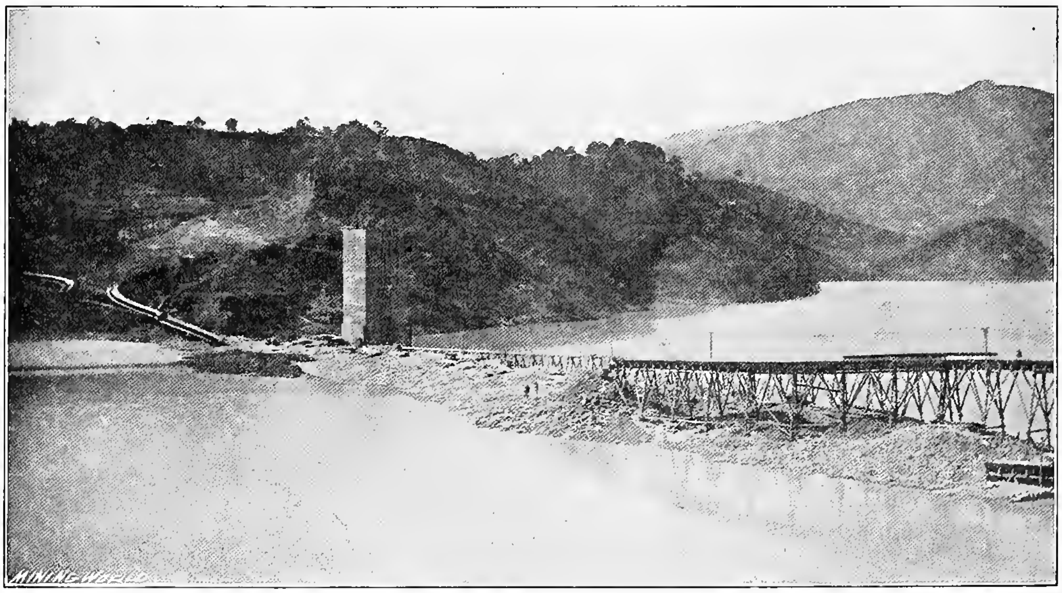
Necaxa is 75 kilometers northeast of Mexico City, in the State of Puebla, bordering on Hidalgo, and about 60 miles distant from the sea, across the State of Veracruz. The Hidalgo railroad starting from the city delivers one at Carmen, where the narrow-gauge,

Shay-engine road of the power company starts. Here there is a commodious and orderly camp capable of well entertaining visitors.

The altitude at Carmen is 2191 meters. From Buenavista reservoir, altitude 2203 meters, capacity 14,000,000 cu. meters, the water passes through the Carmen canal, in place of the Necaxa river. At Carmen the water of the Coaciula river, 1½ meter-seconds, is picked up and passed over the Necaxa river bed by an inverted syphon. The combined flood-waters then flow through the canal and tunnel into the Laguna reservoir, altitude 2180 meters, capacity 45,000,000 cu. meters. At the present time, about 5 meter-seconds are drawn from the Laguna dam, and passed into the Necaxa river, losing considerable head, but utilizing the volume. The flood-water from the Laguna passes by a tunnel into the Los Reyes dam, altitude 2170 meters, capacity 28,000,000 cu. meters. The Los Reyes canal, already constructed, was intended to convey the of the Nexapa reservoir will be picked up by an extensive system of tunnels, considerably augmenting the water supply.

At the present time there are six 5000-kw. generators installed. Two of 10,000-kw. are being added. This will normally increase the output to 50,000 kw. In reality each 5000 generator can maintain 8000 kw. Within two years, on the completion of the present installation, an output of 200,000 kw. is anticipated. Should the larger watershed, with an area of 75 to 20 kilometers, or 1500 sq. kilometers, be harnessed up a total of 300,000 kw. is to be reasonably expected.

Now to revert to the detail, much of which is of surpassing interest. Carmen is connected with Necaxa with a railroad 30 kilometers in length. Originally this was laid out as a wagon road—then traction engines were tried, but were unsuccessful. Finally, the road was converted into a railroad, using Shay engines. It is a marvelous piece of road. So full of



Showing Front of Dam Rebuilt After Accident.

water to power house No. 2, altitude 1409, thus utilizing the head, and passing the water on to the Necaxa dam. This scheme has temporarily been abandoned.

The Necaxa river, carrying the combined waters, now flows through the site of the Texcapa dam, altitude 1400 meters, capacity 18,000,000 cu. meters, thence into the Necaxa dam itself, altitude 1274 meters, capacity 45,000,000 meters. Flowing into the Necaxa reservoir, through a recently constructed tunnel, is the combined water of the Tenango and Nexapa reservoirs, with capacities of 25,000,000 and 20,000,000 cu. ft. respectively. With the completion of the extensive dam now being constructed, the former will have a storage of 45,000,000 cu. meters. A flow of 1½ meter-seconds is estimated to be conveyed through the Tenengo tunnel.

From the Necaxa reservoir the water is conveyed to the power house, altitude 895 meters above sea level. Thus, at a glance, is seen the present and proposed scheme of operations. A large drainage south sharp turns and twists is it that, at times, one is at a loss to conjecture in what direction the engine is heading. The roadbed drops rapidly, and the dial of the aneroid quickly indicates a fall of some 3000 ft. The line crosses an old bridge, known as "Puente de Totolapa," and winds along the steep side of the Necaxa canyon in a charmingly picturesque manner.

After four hours dropping down the Necaxa canyon, following the river the entire distance, the impressive reservoir of Necaxa opens out. The track runs along the strip of territory marked with white "mojoneras," showing the company's grant. Below are seen the meadows, detached villas, and ruins of churches, soon to be inundated with the encroaching flood—a veritable "Philae" of Mexico.

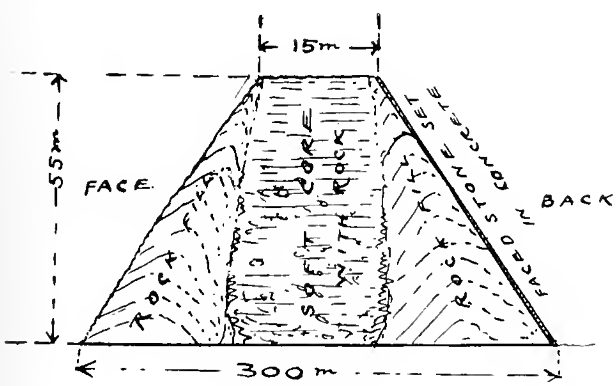
The available head being 2358 meters at Coacoyunance while the power house No. 1 has an elevation of 895 meters, affords a drop of 1463 meters. This shows the potentiality of the larger proposed installation.

The available head from the Necaxa reservoir, to the present power house, is 375 meters.

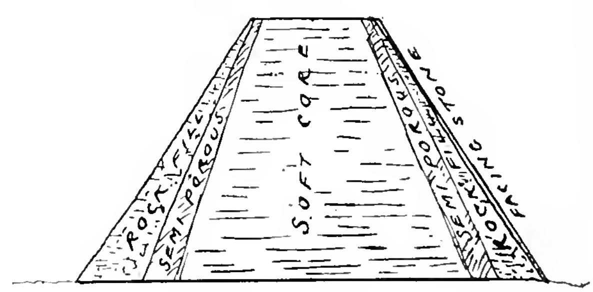
Another site, a few kilometers down stream, affords a fall of 300 meters, rendering possible practically double the output with a duplication of the present plant.

Back Wall—Riprap and Soft Central Core.

At the lower end of the reservoir is situated the Necaxa dam. This is quite notorious, and for more reasons than one. In the first place, it is an example—new to Mexico—of the modern method of dam construction. Then, again, owing to fortuitous circumstances, during the spring of 1909, a serious slide



Amended Construction.



Former Construction.

Necaxa Dam—Hydraulically Deposited.

occurred, carrying out practically —the whole face of the dam. It will be of interest to briefly describe the construction.

The proportions are imposing, embracing 1,600,000 cu. meters. It has a base of 100 meters, 15 meters at the top, and 55 meters high.

The design may be described as a loose rubble wall, slope 1 in 3, carried up, with natural slope inside, at both back and front. In the center is sluiced clay. It has been found that the clay deposited from the water effectually fills the interstices of the loose rock, rendering it watertight. The escaping water, carrying but 3 per cent solids, passes into the reservoir, and is thus utilized. In dam construction, as elsewhere, the local conditions and the material are the determining factors to success. A scheme perfectly feasible in one place may prove a fiasco in another. It is possible that such a reasoning had something to do with the failure of this dam. At all events the design has been considerably amended, as may be seen from the sketches. With the solid rock face and back, and a substantial filling between of the present design, the Necaxa dam will never go out again.

Extensive hydraulic operations, on either side, sluice in through V section, armored flumes, both rock and dirt. Water issuing through 4, 5 or 6-in. nozzles, under 300-lb. pressure, has energy sufficient to tear down the solid limestone of the mountain side, when

loosened with powder. It is a sight full of interest to watch these giants playing about, seemingly operated as easily as a garden hose. The jet trundles the boulders over as readily as if they were of cork. The rebound of the water forms rockets of dazzling whiteness, bearing along the smaller rocks high off the ground. The rocks, both large and small, go humming down the flumes. At the lower end they are deposited and disposed of as required. The cost of such operations is stated to be $1 gold for every cubic meter the dam contains, and it may be double that figure if any mishap occurs. The company has no less than seven dams, either built, started or building. Four of these are each a formidable undertaking.

During December, 1909, the Necaxa dam held abou 7,000,000 cu. meters. It will hold 45,000,000. This means a rise of 60 ft., all but equaling the height of the operating tower seen in the illustration, and almost submerging the small island in the middle distance.

Situated amidst an amphitheater of surrounding hills, pine clad to the summit, the tawny flood reaching back from the solid stone work of the dam, engulfing hill and vale, Necaxa presents a striking picture; and to which, I fear, the camera does scant justice.

The site of Necaxa is interesting besides, by reason of its historical features. In 1856 the French auxiliaries marching to the relief of Maximilian made the "mesa de los flores" their camping ground, and there encountered the hostility of the Indians, by whom, in the rocky passes, they were considerably worsted. Cannon balls and war relics are reported found there to this day.

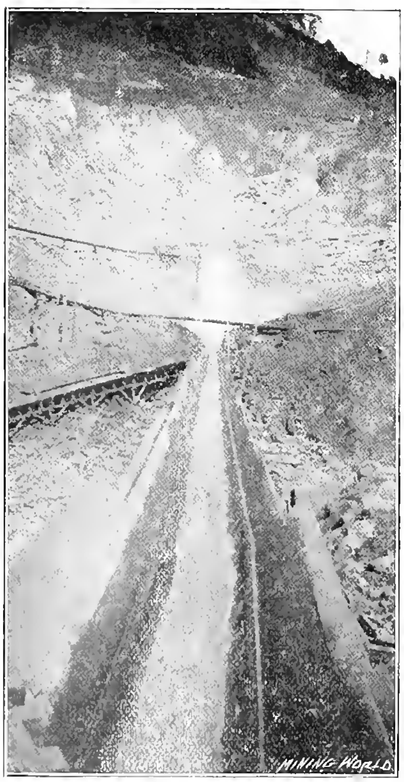
At the bottom of the canyon, close to the foot of the fall, is the power house. The installation consists of six 5000-kw. generators. The volume of water passed through in 24 hours is approximately 500,000 cu. meters. This corresponds to about 7 meter-seconds. During December about 200,000 cu. meters were being drawn from stock. Owing to the lack of storage occasioned by the accident to the Necaxa dam, the storage is below normal. This will not happen again after another wet season, owing to the vastly increased storage for the flood water. In December there were 35,000,000 cu. meters in storage; enough, it is anticipated, with the current supply, to bridge the interval against the normal wet season. A powerful steam plant of 13,000 hp. exists in Mexico City, to render assistance at any time should occasion arise.

To maintain one kilowatt-hour at Mexico City, bus-bars takes 1¼ cu. meters at Necaxa.

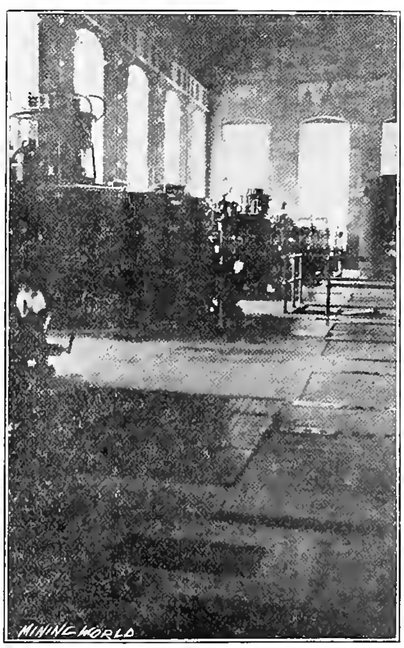
By the first of January, 1910, an addition of from 1 to 1½ meter-seconds was made to increase the supply through the Tenango tunnel.

When the reservoirs, at present completed and under construction, are filled with the surplus waters of the wet season, the storage will be around 155,000,000 cu. meters, sufficient, with the present consumption, to last 300 days. In addition to this is the constant flow, which will be increased from the tapping of the watershed to the south.

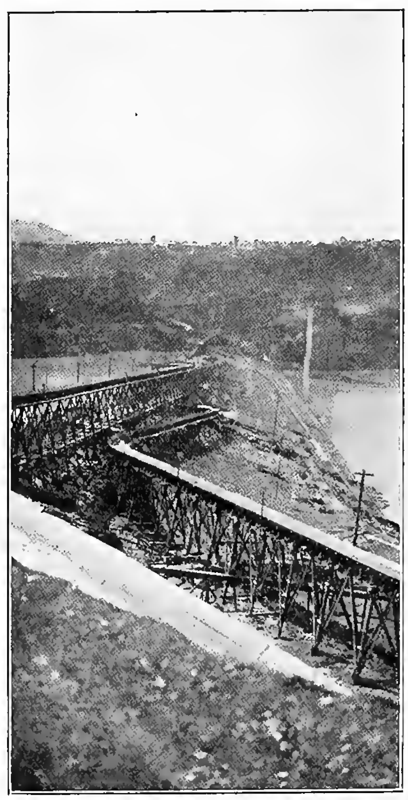
The power house is of solid construction, the machinery substantially erected, and the electrical equipment leaves little, if anything, to be desired. The generators are by the Siemens Schuekertswerte Co. It has been said there are six 5000-kw. generators, with two of 10,000 kw. being installed. Each generator is so liberally calculated regarding copper, that 8000 kw.



Hydraulicking Giant Playing Into Flume



Necaxa Power Station—Interior.


Showing Hydraulicking Flumes.

is readily maintained if desired. The daily load varies from 20,000 to 32,000 kw., probably averaging 24,000 for the 24 hours. Each generator is fixed to a vertical shaft, at the lower end of which is the impact wheel, 9 ft. in diameter. The weight is 36 tons. So efficient is the oil lubrication of the bearing supporting the shaft, that the rotor is easily moved by one finger. This film of oil is maintained under pressure, under ready regulation. The three-throw plunger pumps are regulated by an ingenious device, the speed of the rotor controlling the volume of the issuing jet, through regulation of the aperture of the nozzles. There are two nozzles, at opposite sides. The issuing jet has a velocity of 300 ft. per second. At present the water efficiency is 73 per cent. By the addition of 2 in. in depth to amended buckets, and by installing larger nozzles, the efficiency is expected to be 86 per cent. The output being increased 30 per cent, through increase of efficiency and volume. The orifice is rectangular, operated by powerful toggle-levers.

Although at work over three years, no perceptible wear is noticeable on the steel buckets, notwithstanding considerable sand is carried in the water.

The generators revolve at 500 r. p. m., generating 850 amperes at 4000 volts. This voltage is transformed to 60,000 and carried by three-phase line, No. 000 copper wire, on steel towers to Mexico City.

There are four transmission lines carried on two sets of towers. From the city two transmission lines, also on steel towers, convey the current 125 miles to El Oro, where approximately 12,000 hp. is constantly utilized. New coils are now at the power house to transform to 80,000 volts.

Two independent telephone lines are also strung on the towers, so that conversation with the city and El Oro is readily maintained.

The Necaxa power plant scheme started on comparatively a small scale, mainly the Necaxa reservoir and tributary waters. Then the larger scheme utilizing both pressure and volume from the Laguna dam was proposed, and afterwards discarded. The waters from the Tenango and Catapuxtla rivers were next made tributary by driving of the tunnel. Again other creeks were made tributary by the driving of other tunnels. At this stage 200,000 kw. are to be realized.

Finally the waters from the Coacoyuanca reservoir, 75 kilometers, from the proposed power house No. 3, were secured. From this latter scheme 300,000 kw. are anticipated. The figures embody the duplicating of the power house at the lower altitude. Thus is seen the scope of the present proposals.

The capital financing this enormous enterprise already amounts to $40,000,000, gold. There are employed 7000 operatives, including 100 foreigners. The basis of present and proposed operations cover 1500 sq. kilometers. Railroads connect all the principal points of construction, and ramify in all directions. There are four large dams in course of construction, each of which is a work of magnitude. The work in its entirety embraces at least eight dams. Truly Necaxa is an undertaking of colossal proportions.

The Mexico Light & Power Co. have their head office in Mexico City.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER VII.

(Continued.)

Testing and Adjusting.

To insure the continued accuracy of any watt hour meter it is necessary that it be tested and adjusted from time to time. In the smaller meters it is not necessary to make these tests oftener than about once a year, except in cases of complaint, and when meters are operating under adverse conditions; in the larger sizes, where a small variation in accuracy represents a considerable amount of money, the tests should of course be made oftener, especially where a meter of large capacity is called upon to register a small percentage of its rated load for a great part of the time. As a rule, the conditions under which the meter operates will dictate in a large measure the frequency of the tests.

The experience of the large number of distributing companies that have adopted some method of systematically testing and adjusting their meters has proven that the increased revenue resulting from more accurate meters has much more than offset the additional expense to which they have been put, besides reducing trouble and complaints due to occasional fast meters.

In testing meters which are in service it is much better to test and make any necessary adjustments at the point of installation, rather than to bring the meter into the testing room, since with the proper instruments the same accuracy can be obtained and a great saving in time can be effected. Such practice also avoids those injuries to the meter which are liable to occur in transportation to and from the customer's premises. Of course, where it is necessary to make repairs, it is best to bring the meter to the shop. That particular part of the meter which usually gives the most trouble and which requires the most frequent renewal is the jewel bearing. Jewels and pivots can be renewed at the point of installation without disturbing the meter. Friction in the jewel bearing will result in the meter running slow, and a new jewel should be substituted whenever a defective one is located. When installing a new jewel, a new pivot or ball should also be installed, as the old one is more than apt to have minute particles of the defective jewel imbedded in it, which will constitute an effective cutting tool and will soon ruin a new jewel. In the case of meters employing the ball and jewel bearing it is best to handle the ball with a pair of tweezers rather than with the fingers, as the moisture from the hands may cause the ball to rust.

There are several accurate methods used for testing watt hour meters, and the choice of the method or methods to be used is usually determined by the relative convenience of that method: the most common are (1) the voltmeter and ammeter method, (2) the indicating wattmeter method and (3) the portable rotating standard method.

(To be continued.)

TRANSMISSION LINE CROSSINGS OF RAILROAD RIGHTS OF WAY.

BY A. H. BABCOCK.

It is necessary to protect:

1. The railroad communication circuits (telegraph, telephone and signal) from mechanical injury and from contact with high tension wires.

2. The train crews from personal injuries due to sagging or fallen wires.

3. The trains themselves from mechanical damage and from the liability of fire should a wreck occur at the crossing point.

4. The railroad structures from damage by fire due either to crosses between communication circuits and fallen or sagging transmission circuits or to high potential electro-motive forces induced therein by excessive unbalancing of the transmission circuits.

Having in mind the fact that contact with transmission circuits is dangerous to both life and property, it was natural that the early attempts at protection were of the nature of guard wires, in some form or other.

Many of us have had experience with some such device. Nearly all of us who have had sufficient experience have found unsatisfactory all forms of guards as yet devised. Even those of the deep basket type have failed at times to give complete protection. Furthermore, any pole line is worked at about minimum factor of safety; hence, to increase the load on it at the very point where maximum security is demanded is an engineering anomaly. Prophecy after the fact is easy.

The next step is obvious; to construct the transmission line with maximum factor of safety both in the crossing span and also in each of the adjacent spans, so that nothing short of a general catastrophe shall bring the line into dangerous proximity to the railroad right of way. So well recognized is this principle that the power and the railroad interests are now working in harmonious conjunction to devise an economical mechanical and electrical construction for these crossing spans, so much more secure than that of the transmission line elsewhere, that if ever failure occurs it must be at some other point.

In general, it is advisable, wherever possible, to place underground all low potential power circuits, and communication circuits. The following general specifications cover the points that are now under discussion between the power and railroad companies.

General Specifications for the Construction of Overhead Electric Light or Power Line Crossings.

General.

1. All crossings carrying current at more than nominal 2,300 volts to ground shall come under the provisions of these specifications, unless special conditions in large cities or otherwise shall make a modification thereof necessary or desirable.

2. Complete drawings shall be furnished in duplicate for approval before construction is commenced.

3. The power company shall give the railroad company one week's notice prior to the commencement of work.

4. All work, including the materials entering into the work, shall be subject to the inspection and approval of the railroad company.

5. The power company shall protect the railroad company against any suits for damages arising by reason of any patented devices being used in the work under these specifications.

Clearances.

6. Vertical clearance, under the most unfavorable conditions of temperature or sag, shall be as specified by the railroad company, but shall not be less than 35 feet above the top of rail and not less than 10 feet above any existing wires on the right of way.

7. Side clearance for structures that it may be necessary to locate on the railroad company's right of way shall not be less than 10 feet from the center of the nearest present or proposed track.

Crossing Span.

8. The crossing span shall be carried on towers or poles which shall be self-supporting under the most unfavorable conditions of loading, or of broken conductors.

9. Supports for the crossing span, and for the adjacent spans on each side, are to be generally in a straight line and preferably at right angles to the railroad.

10. Conductor supports shall be guyed away from the tracks in such manner as to make it impossible for the supporting structures to fall toward them.

11. In general, steel towers shall be used, although under certain conditions wooden structures, with concrete or other approved foundations, may be permitted.

12. Foundations shall be designed to resist double the greatest tendency to overturn under the most unfavorable conditions, due to breakage in the line or otherwise.

13. In designing tower foundations, the weight of earth shall be taken at 90 pounds per cubic foot and the weight of concrete at 140 pounds per cubic foot.

14. When towers are used, they shall be constructed of soft or medium soft steel, thoroughly painted or galvanized.

15. Tower construction shall be shown or specified in detail on plans submitted for approval by the railroad company. They shall give sufficient data so that stress diagrams may be constructed for the given loads.

16. All steel structures on the railroad company's right of way shall be grounded in an approved manner and shall be provided with approved danger signs.

17. Steel structures supporting the crossing span shall have a factor of safety of not less than three, based on the ultimate strength of the material and considered under the most unfavorable conditions of loading, wind and broken conductors.

18. Wooden structures supporting the crossing span, and also wooden crossarms, shall have a factor of safety of not less than five, based upon the ultimate strength of the material and considered under the

A paper to be presented at the San Francisco meeting of the American Institute of Electrical Engineers, May 5, 6, 7, 1910. Copyright 1910. By A. I. E. E. (Subject to final revision for the Transactions.)

most unfavorable conditions of loading, wind and broken conductors.

All the following sections shall apply to the crossing span and to each span adjacent thereto:

Pins.

19. Material: cast steel, malleable iron or other crude metal, galvanized.

20. Where wooden crossarms are used, a grounded metal strip must connect all pins electrically.

21. Pins shall be designed for factor of safety of three, under most unfavorable conditions.

Insulators.

22. Material: porcelain only above 7,000 volts, and porcelain or glass below 7,000 volts.

23. Insulators shall be designed for voltages 25 per cent in excess of the rated working voltage of the other insulators on the line.

24. Pin type insulators shall have metal bridge caps, or the equivalent.

25. If suspended type of insulator is used, all connections between the parts of he insulator shall be connections between the parts of the insulator shall be of the interconnected link type, or its equivalent. Whatever type of insulator and attachment is used, the conductor must hold to the supporting structure even if the insulator is mechanically or electrically shattered.

26. Clearance: Insulators shall clear all parts of the supporting structure (except pins and crossarms), not less than 12 inches up to 24,000 volts, plus one inch per 10,000 volts additional.

Conductors.

27. Material: copper, aluminum or other non-corrosive metal. For spans carrying current up to 5,000 volts, minimum size No. 6 B. & S. copper, or aluminum, or other material or alloy of equivalent strength. Above 5,000 volts, minimum size No. 0 B. & S. copper, not less than seven strands (or six strands around a non-conducting center), or aluminum, or other metal or alloy of equivalent strength.

28. Tension shall be adjusted to be equal on each side of the supports of the crossing span.

29. Clearance between conductors and tower structure (except pins and crossarms) shall be not less than 12 inches up to 24,000 volts, plus one-half inch for each additional 1,000 volts.

30. Minimum clearance between conductors shall be not less than 24 inches up to 24,000 volts, plus one inch per 1,000 volts additional.

31. The conductors shall be clamped mechanically to the insulator.

32. The conductors shall be connected to the supporting structure at an auxiliary connection that will insure positive grounding of the conductor in case of failure of the primary insulation.

33. All crossing conductors shall be wrapped or shielded against arcing where they pass over the insulators or through clamps.

34. No splicing will be allowed in any of the three spans named.

35. Crossings shall be designed for one-quarter inch ice radially of weight 60 pounds per cubic foot, plus the weight of the conductor, plus a horizontal wind pressure of 20 pounds per square foot on a projected area of the ice covered cable. (Obviously where ice is never formed, that element of the calculation can be omitted.)

36. Maximum of allowable stress shall be not more than three-tenths of ultimate strength.

37. All calculations shall be based upon a temperature range of 130 degrees Fahrenheit.

The foregoing specifications are tentative in the sense that while they represent the present mutual understanding of the interested parties, they have been adopted merely as a provisional basis for discussion. As such they are submitted for the consideration of the members. It is hoped that your criticism will be constructive as well as destructive.

The following table will serve to show that the subject is one not to be disposed of lightly. With 482 crossings to be legislated for on a single Trunk Line, it is easy to see that the agreement reached must be reasonable and equitable, or it will not stand.

Classification of Power Crossings.

Southern Pacific Company.

Division	Under 2500 V.	2500 to 5000 V.	5000 to 10000 V.	10000 to 15000 V.	15000 to 25000 V.	25000 to 35000 V.	35000 to 65000 V.	Over 65000	Not Listed	Total
Coast ...	119	3	30	13	8	0	5	0	1	179
Western..	47	3	9	7	3	3	42	3	3	120
Sacramento	42	6	6	0	14	0	12	5	..	85
Shasta ...	11	0	0	0	8	0	3	0	5	27
S. Joaquin	6	0	0	3	2	18	0	5	2	36
L. Angeles	1	0	0	0	18	6	0	0	2	27
Tucson ..	1	0	0	0	0	0	0	0	0	1
Salt Lake	1	0	1	2	0	0	2	0	1	7
Total ..	228	12	46	25	53	27	64	13	14	482

ELECTRICAL EQUIPMENT FOR METAL MINE.

To the Editor: I was much interested in the able paper, "Electrical Equipment for Metal Mine," by Mr. R. W. Shoemaker, which furnishes more practical facts than can be found in several volumes of books supposedly written by people who actually know, and no doubt this paper will prove of inestimable value to many engineers.

There are two points in the paper that I trust Mr. Shoemaker will make clear; what was the total head and number of gallons of water handled by the two Cameron pumps requiring a 300-horsepower compressor? and by the centrifugal pulp handling a 25-foot suction without trouble?

It has been the writer's experience and I believe that most centrifugal pump men agree that when the suction head exceeds 15 feet trouble can be looked for, and most makers recommend placing the pump as near the water as possible, for when pumping much above that head air will eventually work into the suction so as to cause the pump to lose priming. The difficulty of priming a centrifugal pump under a 25-foot suction head is a source of annoyance and difficulty.

It appears to me that an easier solution would be the use of direct connected vertical pumps when the pump could be submerged, requiring no priming and the motor set a good, safe distance above high water.

M. C. LORD.

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POWER AND GAS

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue*. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
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Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Institute Meeting

San Francisco is now instructing and entertaining the country's electrical engineers gathered at the high tension meeting of the Institute. The Eastern visitors will take back with them some of the breadth of view which is inspired by a visit to this land of magnificent distances and by their contact with the men who are doing big things in annihilating these distances. We trust that they have but blazed the trail for the rest of their Eastern brothers who would also benefit by holding a national meeting of the Institute on the Pacific Coast.

Load Dispatching

Compare the four-horse chariot of the Roman, the ancient acme of power control, with the two hundred thousand and more horsepower controlled by the load dispatcher mentioned in P. M. Downing's paper this week. That one man should have such tremendous energy under his dominion surpasses the most extravagant conceptions of the Arabian Nights. Yet we have become so gradually accustomed to such wonders that it ceases to arouse more than passing comment.

The various power houses of the Pacific Gas & Electric Company generate over one hundred thousand horsepower, and connected to their transmission lines are other power companies, the Great Western, the Sierra & San Francisco, the Northern California and the Snow Mountain, with an aggregate installed capacity nearly as great. Most of this power is water-generated, steam and gas engines furnishing an auxiliary reserve.

The transmission lines tied together in these systems are nearly two thousand miles in length, the mileage of this combination network of high tension wires being greater than that of any other system in the world. The three hundred and fifty mile stretch from the Kilarc station of the Northern California Power Company in Shasta County to San Francisco is also the longest continuous transmission system in the world. As all of the generators in all these power houses are paralleled, or run in synchronism, the details of their control become of absorbing interest.

The heart of the system, to which all these arteries lead, is the office of the load dispatcher, who has even more responsibility than the chief dispatcher of a railroad. His telephonic approval governs every operation on the system and it is he that apportions the load to each power house and regulates the voltage. In case of accident or any interruption to service he must at once make such adjustments as will insure continuous power and light to the consumer. Every generating plant, transmission line and substation is shown in miniature on a board in this office, together with dummy switches which are set open or closed as may be the condition of the real switches they represent.

Experience has shown that the great size of the system facilitates voltage regulation, just as it is easier to maintain a given water level in a large lake than in a small pond. The inductance and resistance of the lines act as a cushion in case of line troubles, so that a local disturbance but slightly affects the rest of the system. Practically the entire regulation is left to one power house, having great enough capacity to handle all the load fluctuations. The large wattless current due to the inductive drop seems to be best handled by one station, preferably a steam turbine installation which is also available as a reserve.

Simple and obvious as these facts may appear on paper, they represent the patient solution of many vexed problems, requiring years in their unravelling and representing hard work for the pioneers in this great development.

PERSONALS.

W. M. Graham of the Los Angeles office of Holabird, Reynolds & Co. is in San Francisco.

C. R. Dederick of the C. R. Dederick Electric Supply Co. of Portland, Ore., is visiting San Francisco.

H. S. Graves, the new chief forester who recently succeeded Gifford Pinchot, is visiting the Pacific Coast.

H. J. Weigand is visiting San Francisco in the interests of the Cutler-Hammer Manufacturing Company of Milwaukee Wis.

W. S. Heger, Pacific Coast manager of the Allis-Chalmers Company, spent a part of the past week at his Los Angeles office.

T. B. Hunter, manager of the Monterey Water Company of Monterey, Cal. has been spending a few days in San Francisco.

Edward G. Dewald, of the hydraulic department of the Allis-Chalmers Company, is paying a visit to the Northwest Territory.

Leon M. Hall of Hall, Demarest & Co., engineers went to Virginia City the first of the week on business connected with the Comstock mines.

George H. Tontrup, general manager of the American Car Company of St. Louis, has gone to Portland on his way East, after visiting San Francisco.

J. W. Swaren, formerly of the Nevada Machinery and Supply Company, has been made sales manager of the G. W. Price Pump and Engine Company, of San Francisco.

A. H. Barrett, manager of the Louisville Gas and Electric Company of Louisville, Ky., who is making a tour of the Pacific Coast, spent the past week in San Francisco.

L. A. Somers of the Westinghouse Electric and Manufacturing Company's San Francisco sales department, has returned from a trip to Fresno and surrounding territory.

George R. Murphy, manager of the storage battery department of Pierson, Roeding & Co., of San Francisco, has returned from a business trip to Portland and the Northwest.

Beach Thompson, who promoted the Stanislaus Electric Power Company, which has been succeeded by the San Francisco Sierra Power Company, has returned from an Eastern tour.

W. W. Briggs, Pacific Coast district superintendent of the Westinghouse Electric and Manufacturing Company, with headquarters in San Francisco, contemplates leaving next week for a trip to Pittsburg and other Eastern cities.

W. J. Krase, who recently completed the installation of a turbine water wheel generating set for the Pelton Water Wheel Company in the new plant of the Utah Light and Railway Company at Gateway, Utah, is returning to San Francisco.

E. H. Le Tourneau, formerly inspector in the testing department of the New York Central and Hudson River Railroad Company, electric division, New York, has resigned to take charge of the power and electrical equipment of the Exchequer Gold Mining Company at Exchequer, Cal.

Among the Eastern electrical engineers attending the high tension meeting of the American Institute of Electrical Engineers in San Francisco this week were: L. B. Stillwell, president of the institute; Ralph W. Pope, secretary; G. I. Rhodes, engineer Interborough Rapid Transit Company, New York; W. F. Wells, general superintendent Edison Electric Illuminating Company of Brooklyn, N. Y.

A. I. E. E. SAN FRANCISCO MEETING.

Following is the daily program of the San Francisco meeting of the American Institute of Electrical Engineers:

Thursday, May 5th.

9:30 to 11 A. M.—Registration of members and visitors at headquarters in Home Telephone building.

11 A. M.—Paper by Mr. G. I. Rhodes on "Parallel Operation of Three-Phase Generators With Inter-Connected Neutrals."

2 P. M.—Paper by Mr. P. M. Downing, "The Developed High-Tension Network of a General Power System."

Friday, May 6th.

10 A. M.—Paper by Mr. J. J. Frank, "Observation of Harmonics in Current and Voltage Wave Shapes of Transformers."

2 P. M.—Paper by Mr. John Coffee Hays, "Hydroelectric Developments and Irrigation."

Paper by Mr. A. H. Babcock, "Transmission Line Crossings of Railroad Rights of Way."

Saturday, May 7th.

10 A. M.—Paper by Mr. A. M. Hunt, "Emergency Generating Stations for Service in Connection With Hydroelectric Transmission Plants Under Pacific Coast Conditions."

During the meetings the ladies of the party were entertained at various teas and trips to nearby points of interest.

TRADE NOTES.

Henry F. Lyon formerly with Baker & Hamilton, and more recently with the United Iron Works, has opened offices in the Monadnock building, San Francisco, as representative of E. Keeler Company, water tube boilers; The Buckeye Boiler Skimmer Company; Meitz & Weiss, oil engines; the Sims Company, feed water heaters; Clark Engine and Boiler Company; Monarch Soot Blower Company.

H. H. Humphrey, interested in the Central Oregon Power Company, the concern that has an option for the purchase of the Awbrey Falls power project on the Deschutes River, near this place, and contracted for the purchase of 1,000 acres adjoining Lawdlaw, has arrived here and stated that his company would begin immediate work on the power project. The plan is to put in a plant at the falls to develop about 25,000 hp. first, and later to increase the capacity.

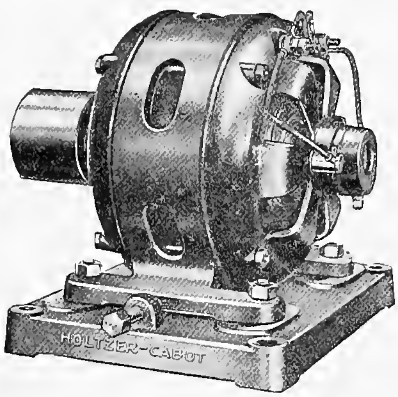
The Kleeb Lumber Company is building a new mill which is designed along the lines of the latest practice in this industry, and which will have electric motor drive throughout. Allis-Chalmers Company is furnishing the power equipment, which will include a 500-kw. 3,600 r.p.m., 60-cycle, 3-phase, 480-volt alternating current steam turbo generator, a surface condenser for maintaining the vacuum, a 15-kw., 120-volt motor generator exciter set, a three-panel switchboard with the necessary controlling apparatus and 22 induction motors ranging from 5 hp. to 200 hp. for driving the machinery about the mill.

A recent and one of the largest hydro-electric developments in California is the awarding of a contract to the Allis-Chalmers Company by the Northern California Power Company for the initial installation of machinery. The contracts calls for all the machinery and accessories and will include the following; Three 7,000 h.p. 450 r.p.m single horizontal turbines with cast iron spiral casings. The runners are 50 inches in diameter and the gate valves 42 inches in diameter. A size 2 oil pressure governor will control them. These trubines are each connected to a 5,000 k.v.a. 6,600 volt 60 cycle three-phase alternator. Excitation current will be supplied by either of two 220 kw. 120 volt generators direct connected to 350 h.p. 525 r.p.m. single impulse turbines controlled by type O governors. The turbines will operate under a head of 450 feet.

INDUSTRIAL

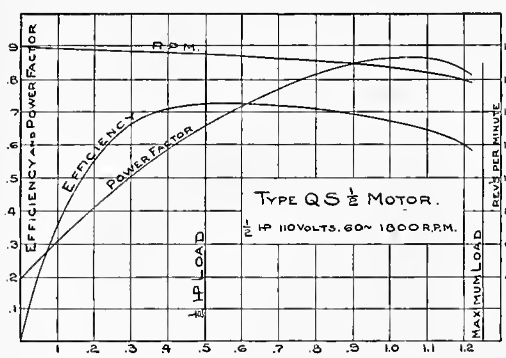
SINGLE-PHASE SELF-STARTING MOTORS.

The Holtzer-Cabot Electric Co. has recently placed on the market a line of single-phase, self-starting induction motors of tbe split phase type. These motors are characterized particularly by compactness, ruggedness and excellent starting and running properties. As these motors require only a double pole switch for controlling them, it is impossible to damage them by opening or closing the switch at any part of the starting cycle and they are particularly adapted to be controlled from a distance.



½-h.p. Single-Phase Motor.

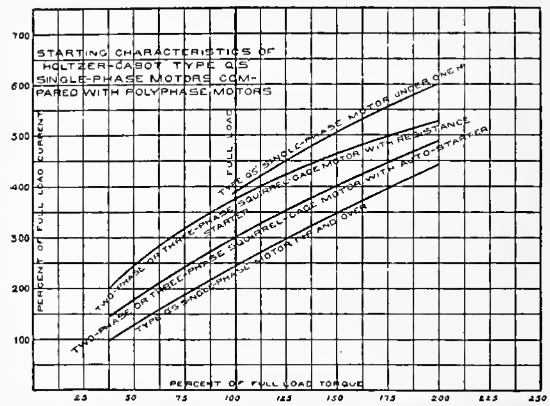
The compactness obtained in designing these motors enables them to be used in many places where there is not room for larger motors. The shafts and bearings, however, are unusually large. Every effort has been made to avoid complications likely to cause trouble. Mechanically the motors follow the type established by polyphase practice the world over. The rotors are of the simple "squirrel cage" type without any combustible insulation whatever, and are therefore practically indestructible. They are keyed solidly to the shaft. No friction clutch, commutator or revolving winding is necessary to enable the load to be started.



Characteristic Curves of ½-h.p. Motor.

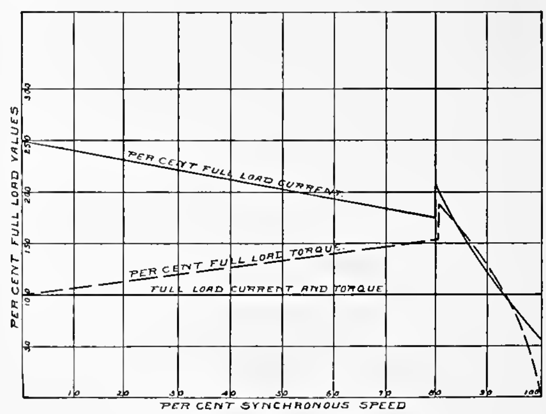
The electrical properties of these motors are particularly good for single-phase machines, as may be seen from the accompanying curves of a half-h.p. motor. The motors are excellently ventilated and the temperature rise under full load is very low. Standard motors will carry momentary loads of 100 to 200 per cent more than rated loads.

In spite of the simple construction, the starting torque and current compare favorable with standard poly-phase practice. Motors of less than 1-h.p will start considerably over loaded with four to five times the full load current. The larger sizes are equipped witb a special phase-splitting device which reduces the current on standard motors to about two and one-half times the running current. With this current, the motors exert full load torque at a standstill. As the speed becomes greater, the current decreases but the torque increases about 50 per cent before the centrifugal switch operates. A tap is provided from the starting compensator by means of which two values of starting torque and current may be obtained.



Comparative Starting Currents for Induction Motors.

In case less than full load is to be started, an ordinary resistance starter may be inserted in one of the circuits thereby cutting down the starting current by an amount proportional to the load.



Speed—Torque—Current Curves.

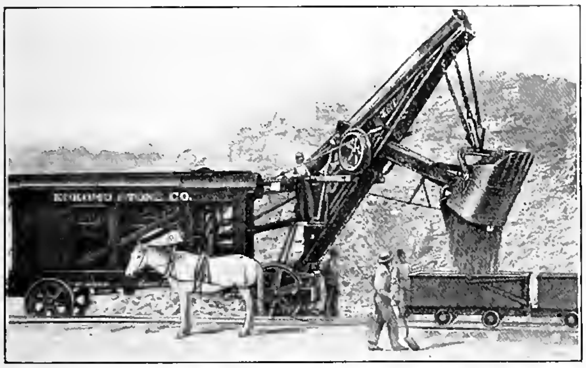
The fact that the starting torque increases with increased speed insures rapid acceleration. It also particularly fits these motors for the large number of cases in which the torque required increases at higher speeds.

TRADE NOTE.

The General Electric Company has sold to the Pacific Electric Railway Company of Los Angeles a 1,000 k.w. motor generator set rated as follows: A. T. I. 12-pole 1120 k.v.a. 500 r.p.m. 2,250 volt 60 cycle synchronous motor mounted on the same base and direct connected to a M. P. C. 8 pole 1,000 k.w. 600 volt generator. Also an exciter rated M. P. 6 pole 14 kw. 500 r.p.m 125 volt mounted on the motor end of the above set.

ELECTRIC SHOVEL.

Where electric power is available, an electric shovel offers many advantages over a steam shovel. Chief among these is the elimination of the boiler, the most annoying part of a steam shovel outfit. Very often the shovel works in territories where good water is not available, and as a result of the inferior feed water the boiler frequently requires repairs. Of course these repairs involve a loss of time and money. Besides, there are the expenses of a fireman, of piping or hauling water, and of hauling fuel, that go to make up a considerable outlay of money in the course of a year. Again, a steam shovel wastes considerable fuel and water at night, especially in winter, as the fire must be kept up to prevent the boiler and pipes from freezing. Furthermore, an important saving arises from the fact that an electric shovel uses power only when it is doing actual work. As, when steam power is used for a shovel, the steam must be kept up all the time, whether the shovel is at work or idle, there is a considerable waste of fuel and water. On an electric shovel, the power is always ready, easily applied, and is not being consumed when the shovel is idle waiting for cars or from any other cause. As soon as the power is cut off from the motors, the consumption of current stops; hence there is no wasts of current whatever.



Electric Shovel.

The electric shovel should appeal strongly to brick and tile manufacturers, to owners of stone quarries, cement plants, electric railroads, placer gold mines and ore mines that are being operated by what is known as the "open cut" method, as a battery of electric shovels operated from a central power plant will affect an enormous saving over steam shovels.

The shovel shown by the photograph is of the Little Giant type, mounted on cast steel traction wheels. It carries a 1¼ cubic-yard dipper and weighs approximately 35 tons. It will make a cut 40 ft. wide in a 10-foot bank and will clear a floor of 26 ft. The point of the crane stands 20 ft. above the ground. The dipper will dump 12 ft. 6 in. above the ground and 21 ft. out either way from the center of the shovel. The car body is 23 ft. long by 7 ft. wide.

The shovel is equipped by three Westinghouse motors as follows: One 60-h.p. motor for hoisting the dipper, one 30-h.p. motor for swinging the crane, and a 30-h.p. motor on the crane for crowding the dipper into the bank. All the motors are for 60-cycle, 2-phase, 220-volt alternating current. The shovel has a capacity of from 600 to 800 cubic yards of the blasted rock shown in the photograph per 10 hour day. It was installed for the Kokoma Stone Company, by the Vulcan Shovel Company, Toledo, Ohio.

NEW CATALOGUES.

Bulletin No. 122, from The Electric Storage Battery Company, illustrates and describes the installation of "Chloride Accumulators" and "Exide" batteries in yachts and power boats.

Bulletin 7A, from the Engineering Department of the National Electric Lamp Association, outlines the historical development of series incandescent lighting and furnishes data on the Mazda street series lamp and its equipment.

In Bulletin No. 4721, just issued by the General Electric Company, are illustrated and described to some extent the company's direct current watthour meters. Types C-6, C-7 and CQ. These meters are made for two- or three-wire service, 100 to 200, 200 to 240, and 500 to 600 volts.

Bulletin No. 5 from Benjamin Electric Manufacturing Company is devoted to Benjamin Mazda-Tungsten Fixtures and Accessories. These include representative requirements for in- and out-door service and corresponding ceiling and pendant fixtures for best utilizing Mazda tungsten lamps.

Bulletin No. 4720 recently issued by the General Electric Company describes in considerable detail the company's steam and air flow meters. The economical generation or consumption of steam, like that of electricity, gas and other commodities, depends on accurate information which will show the amount being generated, consumed or distributed. Equally important is the determination of the exact amount of air being delivered or consumed, where air is used in place of steam as a working agent. The recording and indicating steam and air flow meters described in this publication provide the means for obtaining such information. This bulletin should be of interest to all central station managers.

The Western Electric Company has recently issued its bulletin No. 5360, which takes up the subject of Hawthorn small power motors. The bulletin describes small motors, both alternating and direct current, ranging from 1/6 h.p. to 1/30 h.p., suitable for various purposes, such as buffing and grinding wheels, sewing machines, meat grinders and other household machines which require little power to operate. The direct current motors are built for operation on 110 and 220 volts at various speeds from 1100 to 3400 r.p.m. All of these types may be had with either shunt, series or compound windings. The alternating current small motors are built for 110 and 220 volts at 60, 45 and 25 cycles, single, two and three-phase, at the several synchronous speeds, in a full line of fractional horsepower ratings ranging up to ¼ h.p.

KELLOGG RETURN POSTAL.

Plain facts, what most people want to know about, are sometimes the hardest to find in telephone literature. The average catalogue is an array of glowing statements on what the apparatus will or may do under the most favorable conditions. The "reasons why" are often neglected. There is often too much theory and too little plain discussion of practical points in the work—the kind of questions the "man with the telephone" has to ask about. To further bring out the fact that Kelloog bulletins are practical, especially with reference to magneto telephone work, the Kellogg Company is issuing a return postal folder, entitled "We Can Show You." The operator's difficulties with "rubbering in," signaling central secretly, etc., are mentioned in the postal as being fully explained, with many other features of modern telephone practice, in the Kellogg bulletins, which will be sent promptly on request. The educational features of Kellogg Party Line Bulletin No. 30, written by Mr. H. N. Faris, Kansas City Branch, sales manager, a thoroughly practical telephone man, are well known and appreciated by both novice and veteran in the business. The demand for this bulletin has necessitated a second edition, which is now going to press.

NEWS NOTES

INCORPORATIONS.

REPUBLIC, WASH.—The North Washington Power Company has been incorporated for $200,000 by L. W. Anderson

TOLEDO, ORE.—The Lincoln County Telephone & Telegraph Company has been incorporated for $10,000 by W. K. Merrill.

PORTLAND, ORE.—The Hood River Light & Power Company has been incorporated by John D. Wilcox, Wirt Minor and Robert Smith, all of Portland.

SEATTLE, WASH.—The Alaska Power Company has been incorporated with a capital of $1,000,000 by John D. Atkinson, Central building; Joy T. Hutton and P. C. Stoess, Colman building.

SAN FRANCISCO, CAL.—The Thomas Gas Light & Power Company of California has been incorporated by R. Thomas, F. A. and W. J. Schmalle, J. Weirich and W. W. Hashhurst, with a capital stock of $50,000,000.

SAN FRANCISCO CAL.—The Marysville and Colusa branch of the Northern Electric Railway Company has been incorporated by C. H. Hannon, L. J. de Sabla, S. Lilienthal, C. E. Springer and H. W. Furlong, with a capital stock of $1,500,000.

SAN FRANCISCO, CAL.—The United Light and Power Company has been incorporated at $6,000,000 by Alfred Sutro, F. D. Madison of San Mateo, William T. Barnett of Berkeley, Edward T. Zook of San Rafael and Charles Sullivan of Verano.

SAN FRANCISCO, CAL.—The South Side Light & Power Company has been incorporated with a capital of $1,000,000 by James Fisher, Berkeley; Fred G. Cartwright and T. R. Sullivan, San Francisco; E. R. Hough, Kentfield, and C. N. Beal, San Francisco.

SAN DIEGO, CAL.—The San Diego Electric Fixture Company, with capital of $20,000, has been incorporated. The company will manufacture and sell electric fixtures. The directors are P. W. Dyment, Lottie P. Dyment, B. E. Powers, William Biard and others, all of this city.

PORT TOWNSEND, WASH.—Three streams in the Olympic mountains are to be harnessed for the development of water power for the generation of electricity and commercial purposes. They are the Quicono, Dungoness and Docewallips rivers, all within the boundaries of the Olympic forest reserve. A company has been incorporated under the name of the Olympic Power & Development Company, by W. B. Hartin, J. H. Carston and J. A. Calvett of Seattle, E. A. Sims of Port Townsend and E. W. Holander of Eberott, the capital stock being $250,000 Water sites have been located and the streams will develop between 25,000 and 30,000 horsepower at the lowest stages of the water.

FINANCIAL.

PLEASANTON, CAL.—Pleasanton's $40,000 sewer and water bond issue has been sold to the State of California, on its bid of par, $40 and accrued interest.

EL CENTRO, CAL.—Jas H. Adams & Co. have approved the $69,000 water bonds for a water system here and the bonds are now in the hands of the printers.

BAKER CITY, ORE.—A special election, called for the purpose of voting $200,000 in bonds for the repairs of a water system, resulted in a negative vote on the proposition.

LOS ANGELES, CAL.—A majority of 11,700 out of 13,000 votes was cast in favor of bonding the city for $6,500,000 to improve the harbor and develop 120,000 h.p. along the Owens River aqueduct.

PLEASANTON, CAL.—Pleasanton's $40,000 sewer and water bond issue has been sold to the State of California at a meeting of the Board of Trustees, the bid from that source having been accepted.

FALLON, NEV.—The City Council has introduced an ordinance providing for the issuing of waterworks bonds to the extent of $35,000. Another ordinance was introduced providing for the issuing of $10,000 bonds for the establishing of a sewer system.

SACRAMENTO, CAL.—The Mayor has returned with his approval a resolution declaring the necessity of a municipal filtration plant. Upon this resolution it is proposed to call another election to submit to the people the question of voting $666,000 in bonds to purchase the site and erect the plant.

EUGENE, ORE.—The Council has passed a resolution calling a special election for May 16th, for the purpose of voting on an amendment to the city charter, one authorizing the issuance of $150,000 in bonds for the purpose of refunding outstanding warrants, the other to authorize the issuance of $60,000 in bonds for extending the distributing system of the city waterworks and for a filteration system.

SEATTLE, WASH.—The Council has passed an ordinance authorizing the City Comptroller to advertise for the sale of bonds in the sum of $500,000, being a portion of the $1,080,000 bonds voted by the people at the election last March. The money is to be used for lining the Beacon Hill reservoir and Green Lake Low reservoir; for the cost of the water main in Spokane street and for the purchase of land at Taylor creek.

TRANSPORTATION.

MESA, ARIZ.—Dr. A. J. Chandler of Mesa has gone to Chicago, in the interest of the street railway for Mesa. They will probably build to Chandler's ranch, a distance of nine miles.

FRESNO, CAL.—The Fresno Traction Company has been awarded the Zapp's Park franchise, an extension of the street car system from Blackstone and Belmont avenues to the Kings river.

SAN BERNARDINO. CAL.—The Los Angeles County Electric Company, controlled by the Huntington interest, is to run electric lines between San Bernardino, Riverside, Redlands and Colton.

MILTON, ORE.—The Council has passed an ordinance granting to the Walla Walla Valley Electric Company a franchise to construct and operate an electric railway in certain streets in the city of Milton.

COALINGA, CAL.—The bid made by Judge W. H. Kerr, acting as a right of way agent has been accepted in exchange for the franchise for the proposed electric line connecting Coalinga with the outlying oil fields.

PHOENIX, ARIZ.—The Phoenix Railway Company is building a new car barn, fire-proof, 130 x 65, to replace the one burnt out in February, at which time they also lost six cars. They will probably put in twelve new cars this season, extending the line beyond Indian School for a distance of one and three-fourths miles. They are also extending the Washington-street line.

SAN FRANCISCO, CAL.—The public utilities committee has postponed action upon the application of Thomas W. Forsyth for a street railway franchise on Parnassus avenue, Judah street, Ninth avenue and Pacheco street, being an extension of about one mile of the Masonic avenue line, to allow residents along the proposed route to present written petitions in approval of the work.

SAN FRANCISCO, CAL.—Paul Shoup, assistant general manager of the. Southern Pacific Company, in charge of its electric car lines in California, has accepted the deeds for the right of way for the electric line through Ravenswood. F. E. Chapin, manager of the Peninsular Railroad Company, states that work has begun on the construction of the road. At present the line will be extended as far as the Crow residence, a short distance this side of Cooley's Landing.

DILLON, MONT.—The directors of the Virginia City Southern Electric Railway consisting of L. H. Leber, New York City; W. A. Clark, A. J. Bennett, I. Elling and Geo. E. Gohn, have held a meeting in the office of Clark & Duncan. Mr. Leber was given the authority to sell the bond issue of $200,000 and will go to New York, where he proposes to sell it. He will be back in five weeks and begin work on the construction of the electric railroad connecting Virginia City and Alder, the contract for which has been awarded to him.

GLENDALE, CAL. — The Glendale-Eagle Rock Railway Company has applied for a franchise for an extension of its present line commencing at Glendale and Fourth street, thence northerly along the east side of Glendale avenue to the northern city limits. This company has also made application for a franchise from the north city limits along Glendale avenue to Oak street, where the avenue crosses the Salt Lake Company's Glendale branch line. From Oak street to Verdugo Park a private right of way has been deeded to the company.

TRANSMISSION.

DAYTON, WASH.—A corporation capitalized at $500,000, with this place as headquarters, is being contemplated by the owners of the Waitsburg, Dayton and Pomeroy electric power plants. The proposed power plant of the new organization will be on the Tucanon and will generate 2,500 h.p.

RUPERT, IDAHO—The Secretary of the Interior has awarded contract to the Standard Underground Cable Company of Pittsburg, Pa., for furnishing copper wire to be used in extending the electric transmission line to the towns of Rupert, Heyburn and Burley, on the Minideka irrigation project, Idaho, at $3,263.37.

MANTON, CAL.—The Northern California Power Company's new steam shovel has arrived in camp and will be moved to the Ripley Creek plant to work down the ditch. It is expected the shovel will finish 200 feet of the ditch per day. All tunnels for the Inskip power house have been completed and the plant will be started about June 15th. Perry Crawford has installed the machinery.

NEW YORK—N. W. Harris & Co. have purchased $2,000,000 Pacific Coast Power Company first mortgage 5 per cent bonds, due March 1, 1940. This company, in addition to owning water rights near Seattle and Tacoma, capable of developing 80,000 h.p., owns a large majority of the common stocks of the Seattle Electric Company and the Seattle-Tacoma Power Company, the present income being at the rate of over three and one-half times annual interest charges.

EL PASO, TEXAS—The El Paso Electric Railway have completed a three-mle extension to the race track in Juarez. They are preparing to build fireproof carbarns and will add ten new cars of the prepay type. Pierson & Company will build a sawmill near Nueva Casa Grande on the Mexican Northwestern Railway with a capacity of 800,000 feet in twenty hours, having a power plant of 3-1000 kw. turbines, 16 return tubular boilers, 150 hp. each, and individual motor driven throughout. The bids will be announced later. The Sante Fe at Albuquerque are installing a 150 k.w. Warren generator direct current to an Ideal engine. They are overhauling the switchboard and will install a 150-h.p. return tubular boiler. They expect to sink a deep well to secure water supply for power purposes.

ILLUMINATION.

SAN DIEGO, CAL.—Upon recommendation of the street superintendent, the Council has decided to install a low arm electric arc light at India and C streets.

ELLENSBURG, WASH.—The City Council has granted A. E. Wright of Olympia a 50-year franchise to sell gas for illuminating and fuel purposes in the city oı Ellensburg.

TEMPE, ARIZ.—A bill authorizing Tempe to issue bonds for the amount of $30,000 for the purpose of installing a municipal lighting system in this city, has been introduced at Washington.

FRESNO, CAL.—The local branch of the Pacific Gas and Electric Company is planning to lay pipes before summer through the newly admitted Belmont Addition and in the Forthcamp District.

BEND, ORE.—Frank Robertson, head of the Bend Townsite Company, has returned from Portland and announces that Bend's water system is to be enlarged and electric lighting system to be installed.

PORTLAND, ORE.—After hanging fire for several months, a deal has been made whereby the Hood River Light and Power Company takes over the properties of the Hood River Electric Light, Water and Power Company, for $115,000.

GALLUP, N. M.—The Gallup Electric Light Company, according to G. E. Burgess manager, will completely overhaul the plant this season, putting in a new 150 k.w. three-phase generator direct connected to a new engine and new boilers.

SANTA BARBARA, CAL.—To light the grounds surrounding the Southern Pacific depot and the thoroughfare to the Potter Hotel, five large bronze lamps will be installed at short intervals along the tracks between the station and the hotel.

LOS ANGELES, CAL.—The City Council has passed an ordinance for the furnishing of electric current for a period beginning August 14, 1910 and ending June 30, 1912, and furnishing tungsten lamps and necessary appliances for lighting the ornamental cast iron lighting posts located on Fourth from Main to Hill streets.

LOS ANGELES, CAL.—The Los Angeles Gas & Electric Corporation have recently purchased from the C. H. Wheeler Manufacturing Co. a 16,000 sq. ft. Dry Tube Surface Condenser, one of the C. H. Wheeler Co.'s new Rotrex Patented Vacuum Pumps and a 250 hp. DeLeval Turbine Driven Circulating Pump. The equipment is guaranteed to produce a vacuum of 28 inches when operating in connection with a cooling tower.

OAKLAND, CAL.—Permission has been granted the Central Oakland Light and Power Company, the company which has entered the local field in opposition to the Oakland Gas, Light and Heat Company, to excavate along Alice street between First and Second streets, for the purpose of connecting its present underground electrical system to the power house feeders. The work of laying its system underground is being taken up with rapidity by the new company. It has honeycombed all of the streets of the principal business district, and will soon be distributing electricity for lighting and power purposes.

SAN LUIS OBISPO, CAL.—C. F. Hoffman has presented an application to the Board of Supervisors for a franchise, for a term of 50 years, to lay gas pipes for the purpose of carrying gas for heat, light and power, to erect poles and wires for transmitting electric heat and power, along, under and upon public streets in the judicial township of San Miguel.

SAN FRANCISCO, CAL.—The 85-cent gas rate and the present legal charges for electric light have been renewed by the Supervisors in a bill unanimously passed to print. The action was without discussion or disagreement and on the recommendation of the artificial lights committee. Its final enactment by the board will make effective from July 1st the 85-cent rate, unless the lighting company secures a new injunction from the Federal Court similar to that under which a $1 rate is being collected. The electric light charge is 90 cents per 1,000 watthours, with reductions scaling from 5 to 40 per cent for monthly consumptions amounting to from 2000, 3000 to 9000 watthours.

OAKLAND, CAL.—City Electrician George R. Babcock has begun work in the drawing up of tentative plans and specifications for an extensive gas lighting system, to be installed in lieu of the present arc light system. Babcock is of the opinion that he can install a system of gas lighting on the city's streets which would afford practically twice the amount of light now secured at a cost but slightly in excess of that expended in the maintenance of the present arcs. The city electrician will plan for the maintenance of 12 gas lamps where one arc light is now maintained. These lights are to be placed about 100 feet apart, at a height of between 12 and 15 feet from the ground. In this way, the entire street and sidewalks would be lighted, which is not accomplished through the use of arc lights.

WATERWORKS.

LOS ANGELES, CAL.—A franchise was sold to Puente City Water Company for a pipe line in country roads around the town of Puente.

WALLA WALLA, WASH.—A petition for the construction of a water main on Roosevelt street has been adopted, the improvement to cost $700.

SONOMA, CAL.—L. L. Lewis awarded the contract for the laying of the pipe line from his property west of town to the Pacific Tank and Pipe Company, of San Francisco.

CHIHUAHUA, MEX.—The Department of Fomento has just granted a concession to M. Tamborrel, owner of the Penon Blanco ranch, on the Conchos River, to utilize the waters of the river, both for irrigation and motive power.

WINNEMUCCA, NEV.—The Winnemucca Water and Light Company has purchased the title in the J. N. Thomas and William Nelson ranches in Grass Valley, and a pipe line is to be laid to the head of what is known as Thomas Canyon.

LOS ANGELES, CAL.—Accompanying a petition recently filed with the Supervisors, asking for a franchise to lay water pipes on California street and other streets, in Sunny Slope estate, was a check for $1,000 from the Cribb-Bodek Light and Water Company, to cover advertising expenses. It was ordered that bids be asked for grant.

SPOKANE, WASH.—The City Council disapproved the recommendation of the Board of Public Works that the construction of the two proposed standpipes be postponed until next year. The standpipes are in West Grove and Altomont. The board reported that through an oversight, no provision had been made to connect the new standpipes with heavy water mains and that the cost of doing so would be considerable.

LOS ANGELES, CAL.—Contracts for the construction of a water supply system for Orchard Dale have been let by Davidson Smith & Mizener. Weber & Dullen Company will manufacture and lay 18,000 ft. of 8 in. pipe and 10,000 ft. of 10 in. pipe, dig a trench for laying 6,000 ft. of 14 in. double riveted steel pipe between pumping plant and reservoir, and construct a concrete and corrugated engine house and pumping plant building. M. A. Singer, Whittier, will furnish 12 in. cement pipe.

ASTORIA, ORE.— The Commercial Club of Chino and the Push Club of North Beach are arranging to unite their efforts in securing a water supply for the two places. The feasible source of supply is Press Creek, about three miles from Chinook. The elevation of the proposed reservoir is sufficiently high to provide a gravity system with fire pressure at either town. To supply Long Beach from this point it will be necessary to construct a main eight miles in length and a right of way for the pipe line will be secured adjacent to the railway track.

TRINITY CENTER, CAL.—Seven thousand dollars are to be expended at once in rebuilding the electric power plant of the Trinity Water and Power Company, that was destroyed by fire last fall. The plant is needed to supply power to the Bonanza King mine, now to be resumed. Frank J. Symmes, new receiver for the California Safe Deposit and Trust Company, was authorized by Judge Seawell in San Francisco to make the expenditure. The power company and the mining company are corporations auxiliary to the Safe Deposit Company.

SAN FRANCISCO, CAL.—At the regular annual meeting of the stockholders of the Spring Valley Water Company the following directors were elected: F. B. Anderson, T. B. Berry, W. B. Bourn, A. Borel, S. P. Eastman, E. L. Eyre, C. Osgood Hooker, I. W. Hellman Jr., Homer S. King, E. J. McCutcheon, Louis F. Monteagle, A. H. Payson and J. M. Quay. The board of directors organized by electing W. B. Bourn president; A. H. Payson, vice-president; S. P. Eastman, second vice-president and manager; T. B. Berry, treasurer; J. E. Behan, secretary, and T. M. Edmunds, assistant secretary.

SAN FRANCISCO, CAL.—The Harbor Commissioners have fixed the monthly rental of the Spring Valley Water Company's hydrants on the water front at $250, dating from April 1st. The board had previously fixed the rate at $500 a month, but after a conference with the officials of the company made the reduction. Grain merchants submitted a petition to the board asking for the widening of the seawall grain sheds 80 to 100 feet, in order that deeper water might be provided for vessels docking there, and for the construction of a submerged railroad track on the seawall, for the more convenient handling of grain. Secretary Thorpe was directed to inform the petitioners that there is no money available for the suggested improvement, but that it may be soon forthcoming.

SAN FRANCISCO, CAL.—A contract for the cast-iron pipe specials, consisting of joints, crooks, curves, elbows, etc., to be used in the auxiliary water system for fire protection, has been awarded by the Board of Public Works to the Enterprise Foundry Company of San Francisco, its bid being $89,000. The specials are to be largely made to order, which will allow the department to commence work laying pipe within a few days. The first district to be served will be north of Market and east of Powell streets, work being initiated at several places at one time. It will be done by contract, for which bids will be asked. The contract was awarded to the Enterprise people, theirs being the only bid. Fifteen other foundry operators joined in a letter to the board, refusing to bid because the specifications as prepared made no provision for a strike clause.

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PACIFIC COAST EMERGENCY GENERATING STATIONS[1]

BY A. M. HUNT.

No matter what care and skill are exercised in designing and constructing a hydroelectric plant, with accompanying high-tension transmission lines, absolute continuity of service is a thing which cannot be assured. This is more particularly true of our Western plants as compared with those of the Eastern section of the country, and is especially true in California. Practically all of our important hydroelectric plants are located on streams which find their way down the western slope of the Sierra Nevada range of mountains through deep canyons. The sides of the canyons are usually very steep, and furnish very poor foothold for ditch construction. The cost of driving tunnels is usually prohibitive, and in the majority of cases, box flumes, built of lumber, are used to carry the water.

Steam Turbine Reserve at Oakland Station Great Western Power Co.

Our winter season is one of rains and heavy precipitation, and it is not infrequent that flumes go out, due to water-soaked foundations, slight leaks undermining footings, breaks caused by falling rocks, or other causes. This means an interruption of power service. Interruptions may and do come from line troubles due to many causes.

Interruptions of service were more than occasional in the earlier days of transmission work on the Coast,

[1]Paper presented at the San Francisco meeting of the American Institute of Electrical Engineers, May 7, 1910.

and even today with the better construction and design, and greater care and watchfulness in operation, they occur often enough to be matters for serious consideration.

The best means for avoiding the serious results from interruptions of service, is to reduce the period of time during which power is off the line. Any interruption of service is serious, but if a prospective power purchaser could be assured that his interruptions would be a minimum, and that when they did occur, they would be of very short duration, he would not be so apt to refuse to purchase power from the hydroelectric company on the score that the supply was not dependable. Such shortening of duration of interruption can best be accomplished by having at the receiving and distributing point an emergency generating station, maintained at all times in such a state of preparedness that it can be started and put on the line in the shortest possible time.

Under the conditions existing in California, it may become necessary to operate such a stand-by plant continuously for considerable periods, due to seasons of low water, and it is, therefore desirable that its economy should be good. In fact, I believe I may safely state that no stand-by plant has been installed on the Coast which has not become an important operating factor of the system with which it is connected.

I propose to discuss the type of stations for this service, making comparison between a station having generators driven by gas engines, and one in which steam-driven turbo-generators are used.. I shall try to establish the thesis that the turbine station can be so designed as to be built at much less cost than the gas-engine station; that it can be kept in a state of preparedness where it can be put into service on the line as promptly as the gas engine station; that its stand-by charges will be less than for the gas-engine station; and that its economy, when called on for continuous operation, will be at least as good as that of the gas engine station.

Premises Assumed. The station shall have a capacity for continuous operation of 25,000 kw. at 85 per cent power factor.

Crude petroleum will be the fuel used both for generating steam and for gas making.

The station to be located at a point where spur-track facilities are available, and where ample water supply can be had.

In making comparison of economies with station in continuous operation, it is assumed that the load factor will be 50 per cent.

General Outline of Gas Engine Station.

The station will contain 12 units, each having a continuous load capacity of 2,085 kw. at 85 per cent power-factor. The size of unit is small for a station having such a large capacity, but it is extremely doubtful if any of the engine builders will agree to build and guarantee larger engines, especially for use with gas made from oil. The experience with the large gas engines in the Martin station of the Pacific Gas and Electric Company indicates that the safe limit was passed there.

The following quotations from recent letters received from one of the large gas-engine builders is also confirmatory:

From reports made by various members of our engineering department, who have noted the large continental engines in operation, we gather that while some very large cylinders are still operating in the single-acting type, the European, and particularly the German companies, who have built larger than 42 in. or 44 in. diameter, using cast iron as the material, have been compelled to replace practically all of their cylinders, leads us to believe that they should not be attempted at all in cast iron, and if steel is used with cast-iron bush, the cost per brake hp. will be much larger than a smaller-sized unit, without any gain in efficiency or lessening of operating expense.

If economy is the controlling factor, it would seem to us that a size such as our 37½ in. x 48 in. (3,100 brake hp.), which can be made safely, with cast-iron cylinders would be a better proposition than a larger engine with longer stroke and larger diameter of cylinders which it would be necessary, or desirable, at least, to make of cast steel. We can readily understand how large power houses want turbine units of very large capacity of 10,000 kw. or more, as the economy of the turbine unit increases perceptibly as the sizes grow larger, and these very large units can show economies which are difficult to reach with the smaller sizes, but with the gas engines, if there is any difference at all, the reverse is the more likely to be true, as cylinders of moderate size can be effectively cooled and used with water of ordinary temperatures, while with the very large cylinders, in order to keep certain spots from getting hot enough to ignite the gas, other parts of the cylinders have to be kept unnecessarily cold. The desirability of good parallel operation also tends to cause a choice of smaller cylinder diameters, as with very large engines the slow speed and great number of poles cause the generator builder's requirements for operation to be very close indeed, and the weight of the flywheels becomes prohibitive, both from the point of cost and from the ability of the bearings to stand the load without heating.

The gas required per 24 hours will be 7,500,000 cubic ft., based on 650 B.t.u. per cubic ft., 50 per cent load factor, and assuming that by reason of the relatively small size of units, the engines will always be operated at approximately full load.

The gas-generating plant will consist of three oil gas sets, each capable of producing 2,500,000 ft. of gas per day, with necessary condensers, scrubbers, and purifiers, and a holder capacity of 2,250,000 cu. ft. to equalize the daily load. It is assumed that the units will have twin tandem engines, and the over-all size of foundation for one unit will be 70 ft. by 30 ft. Allowing for passages, the size of electric generating station will be 76 ft. by 400 ft. if engines are placed in one continuous line, or 152 ft. by 200 ft. if placed in two parallel lines. The station will have the usual compressed-air starting equipment.

General Outline of Turbo-Generator Station.

This station will be assumed to contain two turbine units, each having a continuous capacity of 12,500 kw. at 85 per cent power-factor. Each unit will have its condensing equipment, and the boiler plant will contain water-tube boilers in units of the largest size available. The boiler settings to be built so as to lose as little heat as possible by radiation from exposed surfaces. All boilers to have tight fitting dampers, which may all be opened from a central point. The oil and steam supply for burners to be controlled from the same central point, and so arranged that burners may be operated from such point. It is also figured that igniters will be fitted in the furnaces which can be

operated from the central point, so that fires can be started under all boilers simultaneously.

The boiler capacity in the station is assumed to be such, that maximum load can be carried by forcing boilers 33 1-3 per cent beyond builder's rating. This is easily done with oil fuel. Neither economizers nor superheaters will be used.

In connection with the plant will be installed heat storage, consisting of vertical steel cylinders containing water under a temperature due to 200 lb. steam pressure, thoroughly protected with heat-insulating material. The water and steam spaces of these cylinders will be connected with the boilers through automatic stop valves which will open whenever the pressure in the boilers is greater than in the heat storage cylinders. In the heat storage cylinders will be installed internal electric heaters having capacity sufficient to maintain the temperature of the water in them, or, in other words, to supply the heat losses from radiation and convection. The capacity of these heat-storage cylinders to be such, that by reduction of the gauge pressure from 200 to 25 pounds, sufficient steam will be formed to operate the plant at full capacity for thirty minutes. All steam connections to be as short and direct as possible, and all precautions used to keep radiation and condensation losses at a minimum.

On the above assumptions, the following calculations are based:

Rated Horse Power of Boilers Required. The turbines will require at 12,500 kw. load with 175 lb. steam pressure, 28 in. vacuum, and without superheat, 16.69 lb. of steam per kw. hr. To handle auxiliaries of the plant and the oil burners will require 10 per cent of that required for the main units, or the total maximum amount of steam per hour required will be 459,000 lbs. This can be furnished by 11,475 rated h.p. of boilers, working at 33 1-3 per cent overload. It is assumed that this boiler power will be installed in 16 units of 720 rated h.p. each.

The amount of heat storage required in connection with each of the above boiler units is calculated as follows:

When the pressure on water under a temperature due to 200 lb. steam pressure is reduced to 25 lb. about 13 per cent of the water will pass into steam at gradually reducing pressure. The assumption was made that the heat storage shall be capable of furnishing steam for the plant for 30 minutes at full load, or 229,500 lb. This is increased by 33 1-3 per cent to allow for reduced economy of the turbines with the falling pressure, which calls for 229,500 plus 76,500, or 306,000 lb. As 13 per cent of the water in the storage cylinders passes into steam, they must contain 306,000 divided by 0.13, or 2,353,847 lb. Each of the 16 boiler units will, therefore, need 147,116 lb. of hot water in storage. Assuming the water to weigh 60 lb. per cubic foot at temperature due to 200 lb., the volume of the containers will be about 2800 cu. ft. This volume will be provided by one cylinder, 12 ft. in diameter by 26 ft. in length, allowing steam space over the water. Each of these cylinders will weigh approximately 120,000 lb., and will cost delivered and in place not to exceed 6½ cents per lb., or $7,800. Each storage cylinder will supply 1563 kw. of station capacity, or the cost of storage per kw. capacity of plant will be about $5.00. These figures are given to show that the cost is not prohibitive.

Comparisons.

Comparison of First Costs. The cost of the gas-making station, as above outlined, is assumed as being $1,000,000, complete with buildings and storage. The figure is based on data procured within the past two years, and if in error, is possibly too low.

The cost of the electric generating station complete, including gas engines, generators, piping, switchboards, wiring, foundations and buildings will be approximately $2,250,000, based on recent quotations.

At these figures, the cost per kw. capacity of station for combined gas and electric plant will be $130 per kw.

The cost of the steam-turbine plant complete, including turbo-generators, boilers, heat-storage cylinders, piping, condensers, switchboard, wiring, foundations and building will not exceed $1,500,000, based on recent quotations. The cost per kw. capacity of station is, therefore, $60.

The steam-turbine station cost is approximately 46 per cent of that of the gas-engine station.

Comparison as to Rapidity of Getting into Operation on the Line. It has been demonstrated in the Martin gas-engine station, previously referred to, that one of the large engines can be brought up to speed, its generator synchronized, and connected to the line in 30 seconds. In order that this may be done, however, the operator must be at his station when the signal is given. In the station assumed, 12 engine operators would be required, each at his post, all equally trained to accomplish this, and probably an equal number of switchboard operators. Even then, difficulties in synchronizing such a number of machines simultaneously would probably take a longer time. The expense of keeping such a large operating force as this calls for is too great to be feasible, and I assume that each operator will handle two engines, and that he will get the two generators on the line in two minutes. I should consider it exceptional work if the entire station could be in operation on the line in two minutes.

In the case of the steam-turbine plant, the following sequence of operations would be followed: The turbo-generators would be operating on the line as synchronous motors to assist in regulating power factor, and with vacuum maintained on the steam ends, with the air pump operating. Steam would be in the main line up to the throttle valves, also on oil-burner line. If current on the line fails, the rotors of the units will continue to revolve for many minutes. Immediately on notice, the operator will begin opening his throttle valves, and energizing his fields from a storage battery, and could easily synchronize the two machines and get on the line within less than two minutes. The air pump, if operated during the period of starting from the storage battery, would require no attention, and if a jet condenser is used, the only requirement in connection with circulating water is that the injection valve shall be opened.

Concurrently with the above, the boiler-room

operator will release and open all boiler dampers at one operation, and from the same central point, put steam and oil on all burners and by the use of electric igniters start fires under all boilers simultaneously. The steam pressure in the heat-storage cylinders will gradually fall until at the end of 30 minutes it will have reached 25 lb. By the expiration of that time, the boilers can be brought to steaming condition under a pressure of 25 lb. or more, and will pick up the load.

I consider that I have reasonably established the fact that the steam-turbine station can be put on the line as promptly as the gas-engine station.

Comparison as to Stand-by Charges. I shall consider this on the basis of the annual stand-by charge per kw. of capacity of plant.

Assuming that the fixed charges of interest, depreciation and taxes will amount to 10 per cent which favors the gas-engine plant, the annual charge against the gas-engine plant will be $13 per kw. and $6 against the steam-turbine plant.

I will assume that the gas-engine station proper can be taken care of by two crews of six men each at the engines, and two at the switchboard, which is certainly more than fair to it. These men will get not less than $100 per month, or an annual pay roll for station of $19,200.

The gas making plant will also require two crews, each assumed to require six men, which number is an absolute minimum. Their average wages will be not less than $100 per month, or an annual payroll of $14,400. The combined payrolls will be $33,600, or an annual charge of $1.34 per kw. of capacity.

To keep the gas-generating plant in condition such that it can begin making gas with a reasonable degree of promptness, the generators must be kept fairly hot, which will require expenditure of fuel. I have no data of my own as to the fuel necessary for this purpose. Mr. E. C. Jones, chief engineer of the Pacific Gas and Electric Co. informs me that with an expenditure of 150 gal. of oil per day, it is possible to keep a 2,500,000 cubic-foot oil-gas set, at a temperature such that it can be brought to condition for commencing to make gas in 20 minutes. Three such sets will, therefore, take 450 gal. per day. The annual stand-by fuel charge, oil being figured at $1.00 per barrel, will amount to $3,911, or 16 cents per kw. of capacity.

It is assumed that the steam-turbine station will require two crews, each composed of the following: two turbine operators, one switchboard man and two firemen. The average monthly wage is taken at $100 per month, which would make the annual pay roll $12,000, or 48 cents per kw. of capacity. The heat-storage cylinders will be covered with extra thick heat insulating covering, around which will be built an enclosing shell of brickwork. It is assumed that the heat losses per square foot of shell, per Fahr. degree difference of temperature per hour, will not exceed 0.1 B.t.u. The total surface of all heat storage proposed is 37,728 sq. ft. With a temperature of external air of 70 degrees Fahr., the heat loss per hour will be 689,790 B.t.u. The main steam piping that will be under steam will have a surface area of not to exceed 3,500 sq. ft. The loss from this surface is taken as 0.2 B.t.u. per degree difference of temperature per hour, or a total loss on account of such surface of 221,900 B.t.u. The combined loss of 911,690 B.t.u. is equivalent to 359 h.p.-hr., or 270 kw.-hr.

In other words, it will only be necessary to use a little over 1 per cent of the capacity of the plant to keep the heat storage and main steam pipes up to temperature, as the electric heaters will transform the energy at practically 100 per cent efficiency. I think I may safely state that any of our hydroelectric plants have for at least 22 hr. per day energy going to waste in an amount much greater than 1.1 per cent of the peak load, and that under such circumstances the waste energy should not be considered a charge against the plant. The radiation losses, as above taken, would in two hours reduce the temperature of the water in storage less than 1 degree Fahr., so if no waste energy were available for two hours daily, the effect so far as the value of the heat storage is concerned would be negligible. The original heating of the water, and restoration of temperature of the water in the storage cylinders after a run would be accomplished by the use of steam from the main boilers.

It is assumed that steam will be kept on one 300-h.p. boiler, to operate pumps, to supply steam to burner lines and as an emergency precaution. An allowance of 450 gal. per day will maintain pressure on this boiler, and permit the use of 1000 lb. of steam per hour, and at $1.00 per barrel will amount to a yearly charge of $3,911, or 16 cents per kilowatt of capacity.

The stand-by charges per kilowatt capacity of the two plants will be as follows:

	Gas engines	Turbines
Fixed charges	$13.00	$6.00
Pay rolls	1.34	0.48
Fuel used	0.16	0.16
Total stand-by charges..	$14.50	$6.64

The stand-by charges for the turbine plant are less than 46 per cent of those for the gas-engine plant.

It would be entirely legitimate to make a small charge against the gas-making plant for maintaining steam on one of its boilers, but this has been neglected in the above.

If the entire loss of heat from storage cylinders and piping were made good from the auxiliary boiler, the annual fuel charge for this service would not exceed $2,000.

I believe the above discussion proves my statement that the stand-by losses of the turbine station will be less than for the gas-engine station.

Comparison as to Costs of Continuous Operation. If I have been correctly informed, the manufacturers of the large gas engines at the Martin station, previously referred to, guaranteed them to deliver a brake horsepower-hour on 18 cu. ft. of oil gas. No data as to the results actually obtained have ever been given out, but from such information as I have been able to get, I do not believe that the results are any better than those indicated above.

From a paper read before the Detroit meeting of the American Gas Institute by Mr. E. C. Jones, chief engineer of the Pacific Gas & Electric Co., in October, 1909, I take the following data:

There will be required 8 1-3 gal. of crude oil to produce 1000 cu. ft. of gas, and from the process of

lampblack per 1000 ft. of gas made, which should be credited to the gas-making process. A portion of the lampblack will be required for generating steam used in the manufacturing process. It is impossible by any method of treatment so far found economically practicable, to reduce the moisture content much below 25 per cent and it is generally fired when containing at least this much moisture. I assume that at least five of the 20 lb. will be used for generating steam, leaving 15 lb. to be credited.

There is no way in which this lampblack can be used in the plant outlined herein for gas-making, although water gas apparatus could be installed to utilize it. Mr. Jones, in the article previously cited, states that using the lampblack in water gas apparatus, 40 lb. wet lampblack (30 lb. dry) will make 1000 cu. ft., using 6.8 gal. of oil for enriching. As 8 1-3 gal. of oil are used for 1000 cu. ft. of gas under the straight oil gas process, each 30 lb. of lampblack saves 1.53 gal. of oil, or for the 15 lb. excess produced in making 1000 ft. of oil gas, 0.77 gal. In order to give the gas-making process every credit it can be entitled to, I deduct this 0.77 gal. from the 8 1-3 gal., leaving 7.56 gal. net, chargeable to each 1000 cu. ft. of gas made.

If the generator efficiency is 95 per cent, and 18 cu. ft. of gas are used per brake horsepower, the amount used per kilowatt hour will be 25.24 cu. ft. The number of kilowatt hours per barrel of oil, from the data above, is 220.1.

To arrive at the kilowatt hours at the switchboard per barrel of oil in the steam-turbine plant, the following assumptions are made: That the average load-factor on the turbines will be 75 per cent when in operation; that the auxiliaries of the plant will require 10 per cent of the steam taken by the main units; that the evaporation of water will be at the rate of 12 lb. per lb. of oil.

The turbine assumed, is one where the steam consumption at three-fourths load will be no greater than at full load, or 16.69 lb. per kilowatt hour. Adding 10 per cent for auxiliaries gives 18.36 lb. of steam required per kilowatt hour, or at the evaporation assumed, 1.53 lb. of oil. The oil weighs 336 lb. per bbl., and the number of kilowatt hours per bbl. of oil will be 219.6 as against 220.1 for the gas engine. Attendance and fixed charges have been previously shown to be less in the case of the steam plant, so I consider that I have established the remaining statement as to economy made in the earlier part of this paper.

I have endeavored in the argument made to use data and assumptions that in all cases favor the gas-engine station, and feel that on this score I have opened the door to criticism by proponents of steam plants for this class of service.

In closing, I cannot refrain from calling attention to the desirability of fuller information relative to the gas-engine station at Martin, which I have previously cited. Judging from current reports it does not seem to have been an entire success. It is said that it is still in the contractor's hands, five years after installation, and that the purchasing company has abandoned it so far as use is concerned. Nothing has ever been published regarding its difficulties and troubles nor as to its economic results, and I hope that in the discussion of this paper those who know the facts will give the engineering profession the benefit of them.

FEED WATER HEATING AND PURIFICATION.[1]

BY G. N. SUMERVILLE.

A discussion of the subject of heating and purification of feed water might be carried on almost indefinitely, but the object of this is to bring before the operating engineers an outline of results obtained from the Cochrane heaters, manufactured by the Harrison Safety Boiler Works.

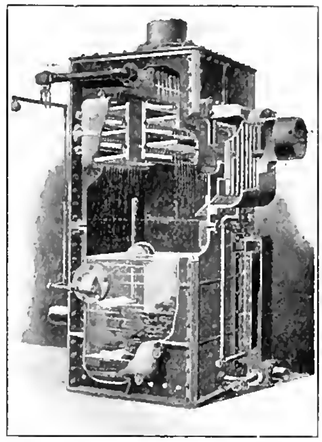
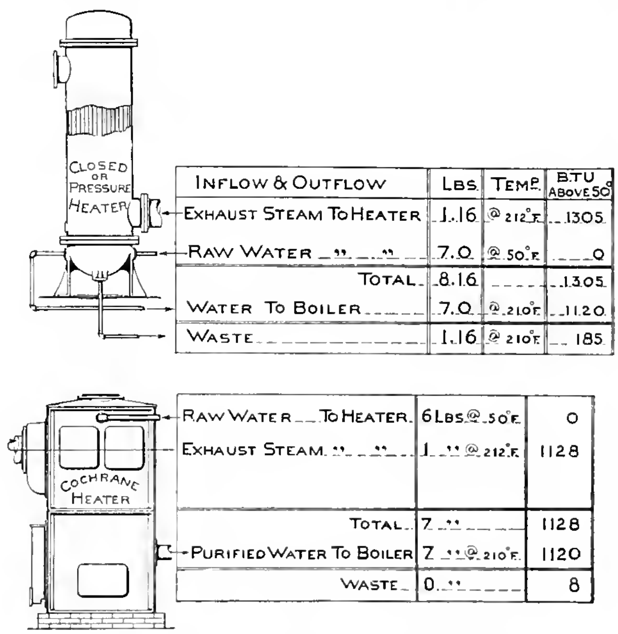


Fig. 1. Heater and Purifier.

In the first place, consider the heat transmission. In the Cochrane heater, Fig. 1, the heating of water is direct and instantaneous, because the steam comes in direct contact with the water. The steam is condensed at once and becomes pure, distilled water, amounting to from 1/10 to 1/6 of the whole boiler



Inflow & Outflow	Lbs.	Temp.	B.T.U. Above 50°
Exhaust Steam To Heater	1.16	@ 212° F.	1305
Raw Water ″ ″	7.0	@ 50° F.	0
Total	8.16		1305
Water To Boiler	7.0	@ 210° F.	1120
Waste	1.16	@ 210° F.	185

Raw Water To Heater	6 Lbs. @ 50° F.	0
Exhaust Steam ″ ″	1 ″ @ 212° F.	1128
Total	7 ″	1128
Purified Water To Boiler	7 ″ @ 210° F.	1120
Waste	0 ″	8

Fig. 2. Comparison of Open and Closed Heater.

supply. The feed water is heated to the full temperature due to the steam, and there can be no falling off in efficiency or capacity, no matter how long the heater has been in use or how full of scale and dirt it becomes.

On the other hand, note what happens in the closed heater: A coating of scale and mud from the water collects on one side of the heating surface and

[1] Paper read before California No. 3, N. A. S. E., Apr. 20, 1910.

oil and grease from the steam on the other side; both coatings hinder the passage of heat; and it is not uncommon to find closed heaters giving a feed water temperature of only 160 or 180 degrees F., although there is a surplus of exhaust steam and although a temperature of over 200 degrees could be obtained if the heaters were clean.

The closed heater, therefore, loses in efficiency from two causes. First, by throwing away the hot condensed exhaust steam and, second, by the fouling of the heating surfaces. From the first cause its efficiency is necessarily from 10 to 16 per cent lower than the efficiency of the other type, no matter how clean the closed heater is kept, and from the second cause the efficiency may be lowered still more, even so that the fuel water reserves only 50 per cent as much heat as it should from the exhaust steam available.

carbonates precipitating at about 200 degrees F., forming a soft, granular scale, while the sulphates are precipitated at about 290 degrees F. and form a hard, crystalline scale.

As the water is heated to 212 degrees in this heater you can readily see that a partial purification is accomplished in the heater by throwing down all the soft scale-forming elements which will precipitate at less than 212 degrees F.

Heater and Receiver.

After the exhaust steam has been used to heat the feed water there still remains present about 80 per cent of the heat in the steam as it left the boilers. It is desirable, if possible, to use this waste steam for heating building or manufacturing purposes. The Cochrane is especially designed for use in connection with any kind of exhaust steam heating or drying system,

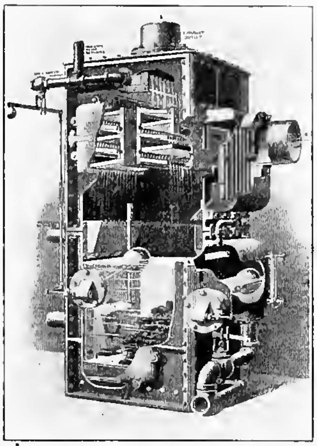


Fig. 3. Heater and Receiver.

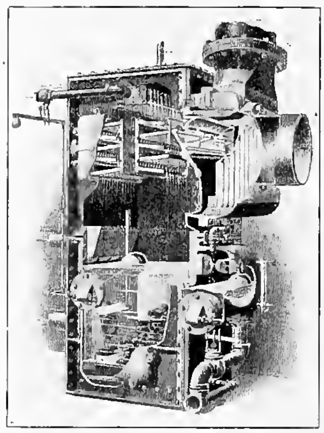


Fig. 4. Cut-Out Valve Heater.

Where the quantity of exhaust steam available is limited—i.e., where it is not sufficient to heat the water to over 200 degrees F., as in most condensing plants—the feed water can be made at least 10 to 20 degrees hotter by means of a Cochrane heater than with a closed heater. Each 10 per cent gained is 1 per cent of coal saved. At the same time the closed heater wastes enough pure water to represent one-tenth to one-sixth of the whole boiler supply. All water is consumed by the Cochrane heater.

In order to use the water over again as a feed water it is necessary that the steam be freed from oil before it is condensed. This is provided for in the Cochrane heater by a separator which is attached to and made part of the heater. (See Fig. 1.) The drain from this separator as well as the overflow from the heater are passed through a water seal to the waste pipe or sewer.

A hot well or return tank is provided for the storage of live steam drips, condensed returns and other hot water about a plant suitable for boiler feeding. The cold make-up water is automatically regulated by a ventilated copper float which controls the supply through a balanced valve in the supply pipe.

As a feed water purifier the Cochrane heater also does valuable work. The most common scale-forming elements found in boiler feed waters are lime and magnesia; which exist as carbonates and sulphates, the

the shell being adapted for carrying any working pressure up to 10 lb. per sq. in. These heaters are further provided with the equivalent of a steam trap, allowing the overflow and drips from the oil separator to pass to waste without permitting steam to escape or air to enter. The returns from the heating system are brought into the heater through a water sealed opening to prevent steam backing up into the return line and so arranged that the returns are broken up and heated by contact with the exhaust steam.

The discharge from vacuum pumps is generally delivered into the top of the heater and passed down over the trap, since it is usually considerably reduced in temperature by the injection of cold water into the vacuum pump. The float controlling the cold water inlet valve is set to close the latter considerably below the overflow level, so that storage is provided for the returns from the heating system.

The best way of installing a Cochrane heater and receiver in connection with a steam heating or drying system depends upon the local circumstances. When the volume of steam is not large it all may be passed through the heater, but where the amount of steam exceeds our stated rating for the separator, the heater is arranged, "to draw," the supply. There are several ways of piping the heater for this purpose, the most simple being to connect the exhaust main to the heater with a branch to the atmosphere, in which is placed a

back pressure valve, while a gate valve is placed between the exhaust to the atmosphere and the heater. The first steam that enters the heater will be condensed by the water flowing over the trap and more steam will follow as fast as it is needed. As a certain amount of air and gas will collect in the heater, a proper vent pipe to atmosphere must be provided. Another arrangement is to pass part of the steam through the heater and by-pass the remainder around the heater through an oil separator. If the exhaust should not be sufficient at certain times, a reducing valve can be so arranged that live steam can be admitted automatically to the heating system as required. Or, better yet, advantage may be taken of open heaters by means of which from $50 to $500 may be saved in the cost of piping, valves, connection, independent separator, trap and other fittings wherever there is a surplus exhaust to be taken care of over what is required to heat the boiler feed.

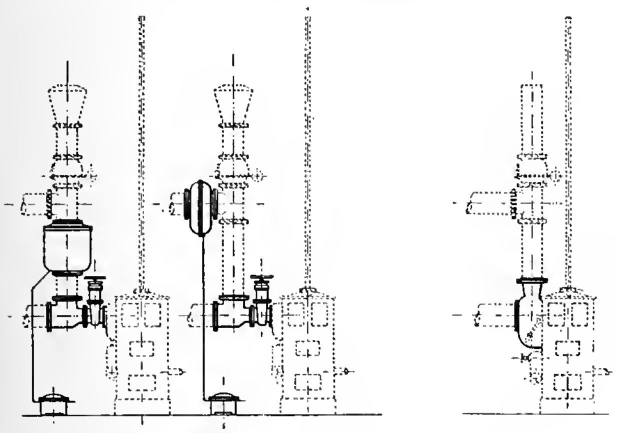


Fig. 5. Diagram of Cut-Out Valve Heater.

Cut-Out Valve Heater.

The important thing about this new heater, Fig. 4, is that the oil separator is large enough to purify all of the exhaust steam delivered by the engines, including the surplus that goes to the heating system, as well as the steam condensed in heating the water in the heater.

By the invention of the open heater, it became possible for one compact apparatus to at once act as hot well, expansion tank, filter, skimmer and make-up water regulator. The new heater has also independent separator, trap, valves and connections for the by-pass. It combines the simplicity and compactness of the thoroughfare arrangement with provision for purifying the surplus exhaust and for cutting the heater out for cleaning while the heating system is in operation. These features are essential to a complete and properly installed "induction," or "draw-the-supply," arrangement.

After the steam has been purified of oil in the separator of this heater, it can either enter the heater shell to heat the feed water or it can escape through the surplus opening or "steam stack," the parts being so placed that the heater has the preference. The steam inlet opening on the separator is in the usual position, while the exhaust opening is at the top of the separator. A vent pipe from the top of the heater provides for the escape of air and gases.

This new arrangement saves not only the cost of an independent separator but also the expense and cost of installing the T's, elbows and the short pieces of pipe that would be required for the installation of by-pass around an old style heater and receiver.

In order that it may be possible to cut the heater out of service for inspection or cleaning while the heating system continues to receive purified exhaust steam through the separator, a semi-rotary valve is arranged to close the passage between the separator and the heater. This valve takes the place of two or more large gate valves required to accomplish the same results where a three-valve by-pass is installed around the old style heater.

To prevent the escape of steam through the separator drain pipe into the heater while the latter is opened, another cut-out valve is placed in the passage between the trap and the heater overflow. Installations have been made where a saving of $500 in the cost of labor and material alone has been realized, as compared with the cost of installing the old style heater and by-pass.

Complete Purification.

Returning again to the purification of feed water, this is an item that confronts most boiler users as a practical problem. Nearly all boiler feed waters contain some scale-forming matter, and statistics collected by the leading inspection and insurance companies show that about one boiler out of every two examined by them is defective in ways that are traceable by impure water.

Scale in boilers means a consumption of an extra amount of fuel in order to force the heat through scale; expenditure to additional boilers to supply steam that the present boilers could furnish if kept clean; outlay for boiler cleaning and for replacements and repairs following upon the use of impure boiler feed water; the cost of firing up boilers put out of service for repairs, cleaning, etc., and, finally, the extra annual depreciation charge on boilers, the life of which is greatly shortened by corrosion, pitting, forcing, cleaning, temperature strains caused by overheating, etc.

The boiler owner wants a commercially practical system of water softening, one that will give the best results as measured by fuel efficiency, and low cost for installation, maintenance and repairs. He further wants a system that is easy to operate and that does not compel him to maintain a chemical laboratory.

If it is attempted to meet these conditions with boiler compounds, it is found that, while they may turn hard scale-forming impurities into sludge, they bring about all the precipitation in the boiler, where the precipitated matter is liable to bake onto the boiler plates and cause burning of plates, besides causing framing.

Boiler tube cleaners are only a makeshift for temporarily remedying an evil that should be prevented. Taking into consideration the men's time, cost of water, cost of cleaners and repair parts, damage to boilers, cost of fuel for firing the boilers up to steam again and interest on plant while idle, boiler cleaning will cost about $1 per h.p. for each cleaning. Further, scale begins to build up again the next day after cleaning and loss of boiler efficiency becomes greater

and greater until the incrustation reaches a maximum which justifies cleaning again. With some waters it is necessary to clean the boilers every two months or oftener.

Live steam purifiers have been installed for the removal of permanent hardness, but they are unsatisfactory and ineffective for several reasons. They do not remove all the scale-forming matters, since calcium sulphate is not precipitated from the feed water even at steam temperature, but will be thrown down only after the solution has been concentrated in the boiler. Live steam purifiers are operated under full boiler pressure; they radiate a considerable amount of heat (from ½ to 4 lb. of fuel per sq. ft. per hour); they must be located above the boiler level, and unless special provision is made and special attention given, the corrosive gases liberated from the water are passed over into the boiler; they are peculiarly subject to water hammer; and, finally, they make no provision for the utilization of exhaust steam.

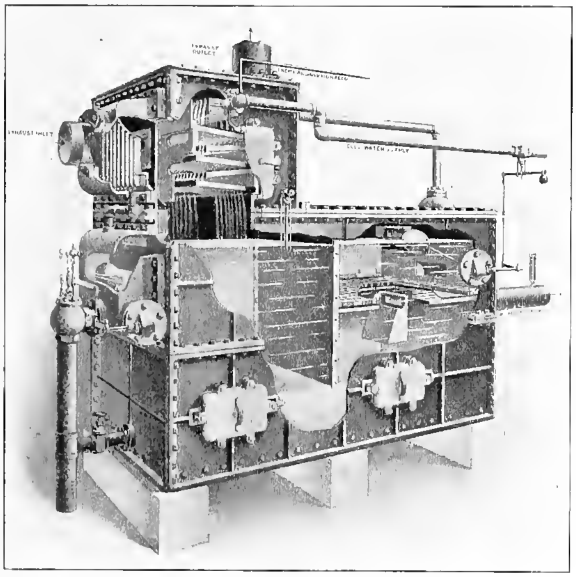


Fig. 6. Hot Process System.

Cold process systems are widely used for softening water in places where heat is non-available, as on railways for locomotive use, but as compared with our hot process system of water softening they involve the purchase of an additional chemical (usually caustic lime or soda), the erection of large, cumbersome tanks and of housing for same, sometimes the pumping of the entire water supply, the lifting of chemicals to a considerable height, expert attention for frequent analyses of the water and for the proportioning and mixing of several chemicals.

This brings us logically to the hot process system, Fig. 6. The chemical reaction involved in softening water is accelerated and assisted by heat; in fact, heat will quite effectively throw down carbonates by driving off the carbonic acid gas which holds them in solution in the water. This leaves only the sulphates, nitrates, chlorides and acids, and all these can be neutralized by one chemical, which is, in fact, the cheapest effective water-softening agent upon the market. Further, where only one chemical is used, the test to indicate whether enough, too much, or too little is used is very simple, and proportioning of the chemical feed correspondingly easy.

The hot process system takes advantage of the fact that boiler feed water should be heated in any case. The purification is already more than half accomplished when the water has been heated in the right kind of heater, and this apparatus takes up the work where the heater leaves off. The functions of the heater are extended so that it not only throws the carbonates out of solution, thereby dispensing with the cost of caustic lime or soda and avoiding the danger of large quantities of scale-forming matter being introduced into the boiler in case the feed of lime should not be exactly proportioned to the amount of carbonates present in the water, but also, so that the one chemical needed can be fed automatically, while further provision is made for the efficient removal of the precipitates by side mutation and filtration.

PRACTICAL MECHANICS.

Paper No. 14.

The Design of Gearing.

Before proceeding with the practical design of gear teeth, it will be well to define some of the terms

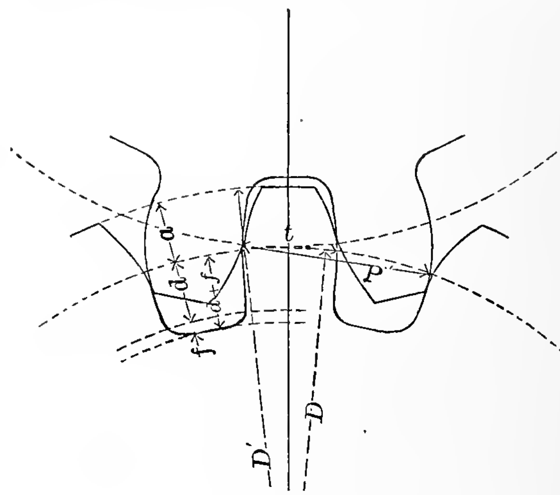


Fig. 16.

with which the designer will be concerned. In Fig. 16 P^1 indicates the circular pitch. This is the distance in inches between similar faces of teeth measured on the pitch circle. This value P^1 must be a certain definite fraction of the whole circumference, since there cannot be other than a whole number of teeth. Hence $P^1 \times N$, the number of teeth $= C$, the circumference, or it may be written $P^1 = \frac{C}{N.}$

There is another term known as the diametral pitch, which is used. This (denoted by P and not possible of measurement in the figure) is the value representing the number of teeth per inch of diameter. Thus, if D is the diameter in inches $P = \frac{N}{D.}$

Now, since the ratio between the circumference and the diameter of a circle is represented by π, then

$C = \pi \times D$ and hence $P^1 = \frac{\pi \times D}{N.}$ But $\frac{N}{D}$ being equal to P, $\frac{D}{N} = \frac{1}{P}$ and so $P^1 = \pi \times \frac{1}{P}$ or $\frac{\pi}{P}$. The usefulness of this term diametral pitch will be brought out later.

In the figure (a) is called the addendum, and is that part of the tooth extending above the pitch circle. From the pitch circle the distance (d) is called the working depth of the tooth, and equals (2a). An additional space (f), the clearance, is provided to prevent the top of the tooth from coming in contact with the bottom of the space which it occupies in the other gear.

The thickness of the tooth is (i); the pitch diameter D; and the outside diameter D.

The addendum (a) is ordinarily chosen equal to $\frac{1}{P}$, thus permits the following relations which may be shown mathematically:

(1) $a = .318\,P^1$ the addendum.

(2) $D^1 = \frac{N + 2}{P}$ the outside diameter.

(3) $2a + f = \frac{2.157}{P}$ the total depth of space.

These formulae give the necessary data to enable the machinist to proceed with the actual cutting of the teeth.

The formula $P = \frac{N}{D}$ gives the relations between size, pitch, and number of teeth. Knowing P and N the second formula gives the overall diameter of the disc when turned ready for cutting the teeth. The last formula gives the depth of the cut into the disc. If now the machinist is provided with the proper template and has worked out the number of teeth, etc., he can proceed with the actual cutting of the teeth.

A method for closely approximating the outlines of cycloidal teeth has been worked out by Mr. George B. Grant. This consists of using the average radius of curvature of the cycloidal arc as the radius of a circle whose arc will very nearly coincide. On this approximation the following table has been worked out. This is inclusive of gears with any number of teeth from a pinion of ten to a rack, i. e., an infinite number.

THREE-POINT ODONTOGRAPH
Standard Cycloidal Teeth
From a Pinion of Ten Teeth to a Rack

Number of Teeth		For one Diametrical Pitch. For any Other Pitch, divide by that Pitch.				For One-inch Circular Pitch. For any other Pitch, multiply by that Pitch.			
		Faces		Flanks		Faces		Flanks	
Exact	Interval	Rad.	Dis.	Rad.	Dis.	Rad.	Dis.	Rad.	Dis.
10	10	1.99	.02	—8.00	4.00	.62	.01	—2.55	1.27
11	11	2.00	.04	—11.05	6.50	.63	.01	—3.34	2.07
12	12	2.01	.06			.64	.02		
13.5	13-14	2.04	.07	15.10	9.43	.65	.02	4.80	3.00
15.5	15-16	2.10	.09	7.86	3.46	.67	.03	2.50	1.10
17.5	17-18	2.14	.11	6.13	2.20	.68	.04	1.95	.70
20	19-21	2.20	.13	5.12	1.57	.70	.04	1.63	.50
23	22-24	2.26	.15	4.50	1.13	.72	.05	1.43	.36
27	25-29	2.33	.16	4.10	.96	.74	.05	1.30	.29
33	30-36	2.40	.19	3.80	.72	.76	.06	1.20	.23
42	37-48	2.48	.22	3.52	.63	.79	.07	1.12	.20
58	49-72	2.60	.25	3.33	.54	.83	.08	1.06	.17
97	73-144	2.83	.28	3.14	.44	.90	.09	1.00	.14
290	145-300	2.92	.31	3.00	.38	.93	.10	.95	.12
	Rack	2.96	.34	2.96	.34	.94	.11	.94	.11

To use the table it is necessary to draw the pitch circles and then the circles of face and flank centers at distances inside of or outside of the pitch circle corresponding to the values given. Thus in a 20-tooth pinion the centers for drawing the tooth faces would lie on a circle whose radius would be .13 inches less than the radius of the pitch circle, while the flank curve centers would fall on a larger circle, the radius

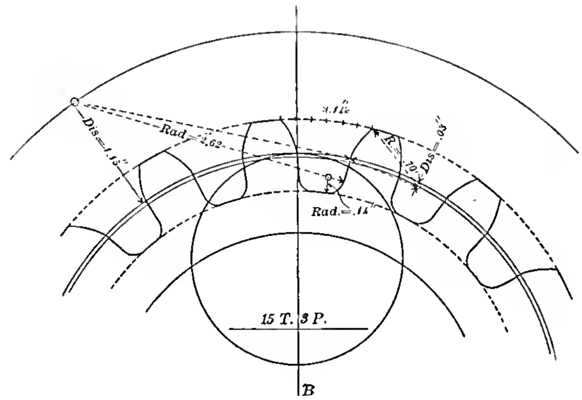


Fig. 17.

of which would be 1.57 inches greater than the pitch circle radius. Having drawn these circles the tooth intervals may be laid out on the pitch circle and then with the radius as indicated and centers on the flank circle, the flank curves may all be drawn in; with corresponding face radius and centers on the inner circle. The face centers are then drawn from the pitch circle out to the outer circle. It is to be noted that the values in the table are for a diametral pitch of one, and that for other pitches the numbers given are divided by the pitch. Fig. 17 shows the construction for a 15-tooth 3-diametral pitch gear. Dividing the

THREE-POINT ODONTOGRAPH
Standard Involute Teeth
Obliquity 15°

Number of Teeth	For one Diametrical Pitch. For any Other Pitch, divide by that Pitch.		For One-inch Circular Pitch. For any Other Pitch, multiply by that Pitch.	
	Face Rad.	Flank Rad.	Face Rad.	Flank Rad.
10	2.28	.69	.73	.22
11	2.40	.83	.76	.27
12	2.51	.96	.80	.31
13	2.62	1.09	.83	.34
14	2.72	1.22	.87	.39
15	2.82	1.34	.90	.43
16	2.92	1.46	.93	.47
17	3.02	1.58	.96	.50
18	3.12	1.69	.99	.54
19	3.22	1.79	1.03	.57
20	3.32	1.89	1.06	.60
21	3.41	1.98	1.09	.63
22	3.49	2.06	1.11	.66
23	3.57	2.15	1.13	.69
24	3.64	2.24	1.16	.71
25	3.71	2.33	1.18	.74
26	3.78	2.42	1.20	.77
27	3.85	2.50	1.23	.80
28	3.92	2.59	1.25	.82
29	3.99	2.67	1.27	.85
30	4.06	2.76	1.29	.88
31	4.13	2.85	1.31	.91
32	4.20	2.93	1.34	.93
33	4.27	3.01	1.36	.96
34	4.33	3.09	1.38	.99
35	4.39	3.16	1.39	1.01
36	4.45	3.23	1.41	1.03
37-40	4.20		1.34	
41-45	4.63		1.48	
46-51	5.06		1.61	
52-60	5.74		1.83	
61-70	6.52		2.07	
71-90	7.72		2.46	
91-120	9.78		3.11	
121-180	13.38		4.26	
181-360	21.62		6.88	

In all cases the centers are on the base circles. Draw rack by special method described in text.

face distance given in the table .09 by 3 gives .03 inches, as shown, while the radius for face curve is 2.1 inches, divided by 3, or .7 inches. The values for the flank circle and radius will be seen to be similarly obtained. The above table was constructed to correspond with cycloidal gear teeth as drawn out by a describing circle equal in diameter to the radius of a gear of 12 teeth. For other sizes of describing circles the values of approximate circle radii would of course be different.

For involute teeth Mr. Grant has worked out a similar table of radii for drawing approximate circular arcs. The centers are taken on the base circles, the flank radius being used from the base circle to the pitch circle and the face radius to describe the arc outside of the pitch circle. Using this approximation it becomes necessary to round off the tips of the teeth to prevent interference and the bases are also flared out to give strength.

Prof. Marx gives as a guide for good design the following: Width of face = 3 times the circular pitch and basing his calculations upon the strength of the weakest section of the tooth, he derives the following formula for the tooth dimensions:

$$(4)\quad F = f \times P^1 \times 6\left(0.124 - \frac{0.684}{N}\right)$$

where

F = the working force as worked out in paper No. 12.

f = the allowable stress in lbs. per sq. in. of section.

6 = width of face, and P' = circular pitch.

For cast-iron and steel the following values for (f) are conservative:

Velocity of pitch line in ft. per min.	100	200	300	600	900	1,200	1,800	2,400
f for steel	20,000	15,000	12,000	10,000	7,500	6,000	5,000	4,300
f for cast iron	8,000	6,000	4,860	4,000	3,000	2,406	2,000	1,700

Some practice will be necessary to enable the designer to obtain the correct proportions between the circular pitch and the width. By several trials, however, assuming certain proportions from a general knowledge of the good appearance of gear-teeth the right dimension, consistent with sufficient strength, will be arrived at. For instance, assume a circular pitch which would seem about right, divide it into the circumference of the pitch circle and thus get the number of teeth. This number must of necessity be a whole round number, since there cannot be a fraction of a tooth and, hence, it will be necessary to take the number nearest that above found and divide back to get the exact pitch. Having obtained this take (b) as three times as large and substitute in the formula (4) and find (f). If the value is very different from that given in the above table for the same velocity another trial will be necessary.

Due to lack of space a complete problem will not be worked out here but should the reader experience difficulty in working out a gear design in accordance with the above outline the Journal will be pleased to have such reader correspond with the editor of the Steam Engineering Department for assistance.

Believing that anyone wishing to master the design of bevel gears will be sufficiently interested to go more completely into the subject than is possible in this series of papers, we shall dispense with that specific case by referring such readers to Le Conte's Mechanics of Machines, Smith & Max Machine Design, and Robinson's Principles of Mechanism.

This will complete the series of papers on the mechanics of transmission, all of the cases originally set forth having been covered in greater or less detail.

CALIFORNIA FUEL OIL.

BY R. F. CHEVALIER.

(Continued.)

Combustion.

From various authorities the ultimate analyses of California oils show them to contain from 81 to 87 per cent of carbon, 11 to 13 per cent of hydrogen, about 1 per cent sulphur, a small amount of nitrogen and oxygen and some water.

Air Supply Required—If a fuel contains oxygen, all the hydrogen shown by analyses is not available for the production of heat. This oxygen is in combination with part of the hydrogen as water, or H_2O, and as the atomic weights of H and O are 1 and 16 respectfully, the weight of the combined hydrogen will be one-eighth the weight of the oxygen, or available hydrogen = H — ⅛ O. From table No. 3 we can calculate the air required for combustion, using the following formula:

Carbon × 2⅔ = lb. O required for C.

$$\left(\text{Hydrogen} - \frac{\text{O in fuel}}{8}\right) \times 8 = \text{lb. O required for C.}$$

Sulphur × 1 = lb. O required for S.

The ultimate analyses of the average fuel oil used may be assumed as follows:

Carbon	86 per cent.	Oxygen	1 per cent.
Sulphur	0.8 per cent.	Nitrogen	0.2 per cent.
Hydrogen	12 per cent.		

By use of table No. 3 and the above formula, the air required per pound of fuel is easily calculated.

TABLE NO. 3.

OXYGEN AND AIR REQUIRED FOR THE COMBUSTION OF CARBON, HYDROGEN, ETC.

Combustible.	Chemical Reaction.	Product of Combustion.	lb. of Oxygen	lb. of Nitrogen	lb. of Air	lb. of Gaseous Products	Heat generat'd B. t. u.
Carbon	$C+2O=CO_2$	Carbon Dioxide	2 2/3	8.85	11.52	12.52	14,600
Carbon	$C+O=CO$	Carbon Monoxide	1 1/3	4,43	5.76	6.76	4 450
Carbon Monoxide	$CO+O=CO_2$	Carbon Dioxide	4/7	1.90	2.47	3.47	10.150
Hydrogen	$2H+O=H_2O$	Water	8	26.56	34.56	35.56	62.030
Methane	$CH_4+4O=CO_2+2H_2O$	Carbon Dioxide and Water.	4	13.28	17.28	18.38	23,550
Sulphur	$S+2O=SO_2$	Sulphur Dioxide	1	3.33	4.32	5.32	4,050

$$.86 \times 2\tfrac{2}{3} = 2.2933 \text{ lb. oxygen.}$$
$$(.12 - \tfrac{.01}{8}) = .95 \text{ `` ``}$$
$$.008 \times 1 = .008 \text{ `` ``}$$
$$\text{Total} = 3.2513 \text{ lb. oxygen.}$$

As one pound of oxygen is contained in 4.32 pounds of air, the total amount of air required would be 3.2513 X 4.32 = 14.045 lb.

To better illustrate the combination of the elements in oil fuel with air during combustion, and the steam used to atomize the oil, the following tabular view has been arranged. It is assumed that to atomize one pound of oil .5 of a pound of steam is required.

TABULAR VIEW OF FURNACE COMBUSTION.

			Pounds.
Entering Furnace	1 pound Fuel Oil	Carbon	.86
		Hydrogen	.12
		Oxygen	.01
		Nitrogen	.002
		Sulphur	.008
	14.0456 pounds Air	Oxygen for CO_2	2.2933
		Oxygen for H_2O	.95
		Oxygen for CO	
		Oxygen for SO_2	.008
		Nitrogen	10.7943
	Atomizing Agent	Steam	.5

Waste Products in Chimney.

	Pounds.	Per cent. by weight.
CO_2	3.1533	20.3%
Steam (H_2O)	1.58	10.17
CO	0.00	0.0
SO_2	.016	0.1
N	10.7963	69.43
	15.5456	100.00

Comparison of Combustion of Coal and Oil.—In burning bituminous coal, when fresh fuel is thrown on a fire, it is heated by the coal already burning and combustible gases are distilled which mingle with the oxygen and burn back of the bridge wall in the space known as the combustion chamber. The coke that is left burns on the grate with very little flame. In this way half of the heat is generated by the burning gases in the combustion chamber, and the balance is generated by the hot coals on the grates in the furnace. A large part of the air entering for combustion must pass through the hot coals where part of the oxygen is used, the remainder passing on to mingle with the gases distilled from the coal, in the combustion chamber. As gases tend to move in straight lines, considerable excess air is required for their diffusion, unless thrown out of the line of their travel by a bridge wall or other obstruction.

TABLE NO. 4.

Weights and Gravities of Fuel Oils at 60° Fahr.

Beaume scale gravity	Specific gravity	Wgt. per gal. in lbs.	Wgt. per cu. ft. lbs.	Wgt. per bbl. in lbs.	Gallons per ton	Bbls. per ton	Cu. ft. per ton
10	1.0000	8.33	62.5	349.86	268.9	6.40	35.84
11	.9929	8.27	62.06	347.34	270.8	6.44	36.09
12	.9859	8.21	61.6	344.82	272.9	6.49	36.5
13	.9790	8.16	61.2	342.72	274.5	6.53	36.6
14	.9722	8.10	60.8	340.20	276.5	6.58	36.8
15	.9655	8.04	60.34	337.68	278.6	6.61	37.1
16	.9589	7.99	59.9	335.58	280.3	6.67	37.4
17	.9523	7.93	59.5	333.06	282.4	6.72	37.6
18	.9450	7.88	59.1	330.96	284.2	6.77	37.9
19	.9395	7.83	58.7	328.86	286.	6.81	38.1
20	.9333	7.78	58.33	326.76	287.9	6.88	38.6
21	.9271	7.72	58.	324.24	290.	6.9	38.6
22	.9210	7.67	57.6	322.14	292.	6.95	38.9
23	.9150	7.62	57.2	320.04	294.	7.00	39.1
24	.9090	7.57	56.8	317.94	295.9	7.04	29.4
25	.9032	7.53	56.45	316.26	297.4	7.08	39.7

With liquid fuel the first requirement is complete atomization. Before oil can be mixed with the air in a furnace it must be converted into a vapor by the radiant heat of the furnace.

Oil leaves a residue of coke when it is vaporized. On leaving the burner-tip the oil commences to evaporate while traveling across the furnace, and the gase, mixing with the air, burns immediately. The residue, which is the carbon in the form of small specks of coke, will burn providing it is not deposited on the floor or side-wall of the furnace before being consumed. If these carbon deposits are of the consistency of asphalt, they will form a hard deposit difficult to remove, impairing the draft and causing more accumulation of carbon.

Carbon burns more slowly than gas. From this we may assume that the dazzling white part of an oil flame near the burner is caused by the combination of hydrogen and hydrocarbon gases with oxygen, and the more luminous or orange tinged part of the flame furtherest from the burner-tip is due to the combustion of the carbon. This fact is borne out by the temperature of oil flames determined by the writer, the data of which will be given later.

(To be Continued.)

ECONOMY IN USE OF OIL ON P. R. R.

A comparison of the amounts of oil and grease issued to Panama railroad locomotives for the months of January, February and March, 1909 and 1910, shows the following saving or excess:

	Gallons 1909	Gallons 1910	Saving
Oil:			
Valve	1,558	778	780
Engine	1,598	1,200	398
Car	436	18	418
Signal	484	65	419
Headlight	459	349	110
Machine	2	*1	...
Coal	193	143	50
Lard	*1	†2	...

*One month. †Two months.

	Pounds 1909	Pounds 1910	Saving
Tallow	*4	†14	...
Cup grease	301	330	‡29
Cotton waste	2,927	1,475	1,452
Woolen waste	242	279	‡37
White waste	...	42	‡42

*One month. †Two months. ‡Excess in 1910 over 1909.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER VII.

(Continued.)

Testing with Indicating Instruments.

The voltmeter and ammeter method can only be used with direct current watt hour meters, or with alternating current watt hour meters when the power factor is unity or its exact value known; the connections for this method are shown in Fig. 87, where V is the voltmeter, A is the ammeter and W the single phase watthour meter being tested. If E is the

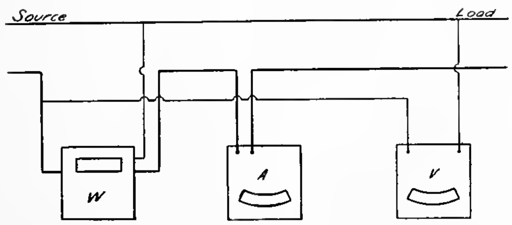


Fig. 87.

voltage impressed upon the circuit, and I the current in amperes, then the power (unity power factor) is $P = E \times I$.

The indicating wattmeter method of testing watt hour meters is applicable to alternating currents regardless of what the power factor may be, so with this method the power, P, is read direct. Fig. 88 shows the connections for this method of testing.

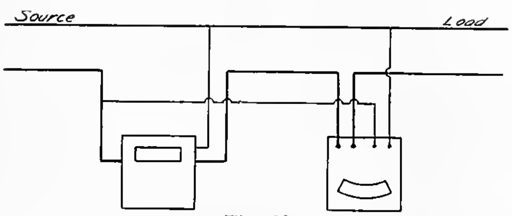


Fig. 88.

Each revolution of the meter disc represents a certain number of watt hours of electrical energy passing through the meter, which is given in some types of meters directly in the form of the meter "constant," and in such meters, if R is the number of revolutions of the disc in t seconds (as measured with a stop watch), and with constant power passing through the meter, then the watt hours would be $= R \times K$, where K is the meter "constant." But the power P=watt seconds per second=watt hours x 3,600 divided by the time, t, therefore we have

$$P = \frac{R\ K\ 3{,}600}{t}$$

The constant, K, for the General Electric meters will be found marked on the meter disc, and are also reproduced in the accompanying tables.

DIRECT CURRENT METERS.

	100-120 Volt Type C-6				200-240 Volt. 2 and 3 wire, Type C-6				500-600 Volt Type C-7			
Amps.	Meter "K"	Reg. Ratio	Dial Const.	Watts per r.p.m.	Meter "K"	Reg. Ratio	Dial Const.	Watts per r.p.m.	Meter "K"	Reg. Ratio	Dial Const.	Watts per r.p.m.
5	.2	500	none	12	.4	250	none	24	1	100	none	60
10	.4	250	"	24	.75	133.33	"	45	2	50	"	120
15	.6	166.66	"	36	1.25	80	"	75	3	33.33	"	180
25	1.0	100	"	60	2.00	50	"	120	5	20	"	300
50	2.0	50	"	120	4.00	25	"	240	10	10	"	600
75	3.0	33.33	"	180	6.00	16.66	"	360	15	66.66	10	900
100	4.0	25	"	240	7.50	13.33	"	450	20	50	10	1200
150	6.0	16.66	"	360	12.50	80	10	750	30	33.33	10	1800
300	12.5	80	10	750	25.00	40	10	1500	60	16.66	10	3600
600	25.0	40	10	1500	*50.00	*20	10	300	125	80	100	7500

*Applies to 600 amperes, two wire meters only: 600 ampere, three wire meters are not manufactured.

General Electric, Type "I," Standard 60 Cycle, Single Phase Watthour Meters.

	100-130 Volt 2 Wire		200-260 Volt 2 and 3 Wire		500-600 Volt	
Amps.	Meter "K"	Watts per r.p.m.	Meter "K"	Watts per r.p.m.	Meter "K"	Watts per r.p.m.
3	.2	12	.4	24	1	60
5	.3	18	.6	36	1.5	75
10	.6	36	1.25	75	3	180
15	1	60	2	120	5	300
25	1.5	90	3	180	7.5	450
50	3	180	6	360	15	900
75	5	300	10	600	25	1500
100	6	360	12.5	750	30	1800
150	10	600	20	1200	50	3000
200	12.5	750	25	1500	60	3600
300	20	1200	40	2400	100	6000
			Polyphase, 60 Type "D-3."			
3	.4	24	.75	45	2	120
5	.6	36	1.25	75	3	180
10	1.25	75	2.5	150	6	360
15	2	120	4	240	10	600
25	3	180	6	360	15	900
50	6	360	12.5	750	30	1800
75	7.5	450	15	900	40	2400
100	12.5	750	25	1500	60	3600
150	15	900	30	1800	75	4500

For General Electric meters used with current and potential transformers, but calibrated without them, the constant to be used is that marked on the meter disc, divided by the product of the ratios of the potential and current transformers. The worm reduction in all General Electric meters is 100 and will be found stamped on the back of the register. The register ratio multiplied by 100=number of revolutions of disc for one revolution of the right hand pointer. In all cases, the meter, K, is the actual number of watt hours per revolution of the disc.

$$\text{Meter Constant, } K = \frac{\text{*Rating in (volt-amperes)}}{\text{Full load r.p.m. of disc} \times 60}$$

$$\text{Register Ratio} = \frac{\text{Watt hours of right hand dial}}{\text{Worm reduction} \times K}$$

(*For polyphase meters, the rating should be multiplied by 2. In case a meter has a double rating, such as 110/220 volts, the latter voltage should be applied in the formula. The approximate full load speed of all G. E. type "I" and "D-3," 60 cycle meters is 30 r.p.m.)

Westinghouse Meter Constants.

For different makes of meters, the testing formula given takes a different form since the constant K is made to embrace different factors.

For the Westinghouse meter, the formula becomes

$$P = \frac{R \times K}{t}$$

where K represents the watt-seconds for one revolution of the meter disc.

The values of the constant, K, for the Westinghouse types B and C and for the direct current meters are as follows:

2-wire D. C. and self-contained single phase, K = volts x amps x 2.4;

2-wire single phase used with *current* transformers *only* (but checked without), K = volts x 5 x 2.4;

2-wire, single phase used with *current* and *potential* transformers (but checked without), K = 5 x 100 x 2.4;

2-wire, single phase, used with transformers of either or both forms (and checked with), K = volts x amps x 2.4;

3-wire, single phase, self-contained, K = volts x amps. x 4.8.

3-wire, single phase, used with current transformers (but checked wtihout), K = volts (as marked on meter) x 12:

Type "C" polyphase, self-contained, K = volts x amps x 4.8;

Type "C" polyphase, used with *current* transformers only (but checked without), K = 5 x volts x 4.8;

Type "C" polyphase, used with current and potential transformers (but checked without), K = 2400;

Type "C" polyphase used with transformers of either or both forms (and checked with), K = volts x amps x 4.8.

In all cases, the volt and ampere values referred to are those as marked on the name plate of the meter. The full load speed of the types B and C is 25 r.p.m. For the Westinghouse type A meter, the full load speed is 50 r.p.m., and the constant, K, for this type is exactly one-half the value of a similarly rated type C meter.

Fort Wayne Type K Meter.

The calibrating equation of the Fort Wayne type K meter is as follows:

$$P = \frac{R \times K \times 100}{t}$$

where t is the time in seconds during which the meter makes R revolutions, and where K is the constant, which will be found in the following tables:

Fort Wayne, Type "K," Single Phase, 60 Cycle Watthour Meters whose Serial Number is 344,999 or less.
Values of the Constant, K.

Amps.	2 wire 50 volt	2 wire 110 volt	2 wire 220 volt	3 wire 220 volt	2 wire 550 volt	2 wire 1100 volt	2 wire 2200 volt
3	..	9	18	18	45	90	90
5	9	9	18	18	45	90	180
7.5	..	..	..	27	..	..	..
10	9	18	36	36	90	180	360
15	18	36	54	54	180	360	540
20	18	36	72	72	180	360	720
25	18	36	72	72	180	360	900
30	36	72	90	90	360	720	1080
40	36	72	108	108	360	720	1440
50	36	72	144	144	360	720	1800
60	54	108	180	180	540	1080	2160
75	54	108	216	216	540	1080	2700
100	72	144	288	288	720	1440	3600
125	90	180	360	360	900	1800	4500
150	108	216	432	432	1080	2160	5400
200	144	288	576	576	1440	2880	7200
250	180	360	720	720	1800	3600	9000
300	270	540	1080	1080	2700	5400	10800
400	360	720	1440	1440	3600	7200	14400
500	450	900	1800	1800	4500	9000	18000
600	540	1080	2160	2160	5400	10800	21600
800	720	1440	2880	2880	7200	14400	28800
1000	900	1800	3600	3600	9000	18000	36000
	Use These Constants for High Torque Meters.						
15	13.5	27	54	54	135	270	540
30	27.0	54	90	90	270	540	1080

Fort Wayne, Type "K," Single Phase, 60 Cycle Watthour Meters, whose Serial Number is 315,000 or above.
Values of the Constant, K.

Amps.	2 wire 110 volt	2 wire 220 volt	3 wire 220 volt	2 wire 440 volt	2 wire 550 volt	2 wire 1100 volt	2 wire 2200 volt
5	9	18	18	36	45	90	180
10	18	36	36	72	90	180	360
15	27	54	54	108	135	270	540
20	36	72	72	144	180	360	720
25	45	90	90	180	225	450	900
40	72	144	144	288	360	720	1440
50	90	180	180	360	450	900	1800
75	135	270	270	540	675	1350	2700
100	180	360	360	720	900	1800	3600
125	225	450	450	900	1125	2250	4500
150	270	540	540	1080	1350	2700	5400
200	360	720	720	1440	1800	3600	7200
300	540	1080	1080	2160	2700	5400	10800
400	720	1440	1440	2880	3600	7200	14400
600	1080	2160	2160	4320	5400	10800	21600
800	1440	2880	2880	5760	7200	14400	28800

Fort Wayne, Type "K," Polyphase Meters whose Serial Number is 344,999 or less.
Values of the Constant K.

Amps.	110 v.	220 v.	440 v.	550 v.	1100 v.	2200 v.
3	18	36	72	90	180	360
5	36	72	144	180	360	720
10	72	144	288	360	720	1440
15	108	216	432	540	1080	2160
20	144	288	576	720	1440	2880
25	144	288	576	720	1800	3600
30	216	360	720	1080	2160	4320
40	288	576	1152	1440	2880	5760
50	288	576	1152	1440	3600	7200
60	432	864	1728	2160	4320	8640
75	432	864	1728	2160	5400	10800
100	576	1152	2304	2880	7200	14400
125	720	1440	2880	3600	9000	18000
150	864	1800	3600	4320	10800	21600
200	1440	2880	5760	7200	14400	28800
250	1800	3600	7200	9000	18000	36000
300	2160	4320	8640	10800	21600	43200
400	2880	5760	11520	14400	28800	57600
500	3600	7200	14400	18000	36000	72000
600	4320	8640	17280	21600	43200	86400
800	5760	11520	23040	28800	57600	115200
1000	7200	14400	28800	36000	72000	144000

Fort Wayne, Type "K" Polyphase Meters whose Serial Number is 345,000 or above.
Values of the Constant, K.

Amps.	110 v.	220 v.	440 v.	550 v.	1100 v.	2200 v.
5	36	72	144	180	360	720
10	72	144	288	360	720	1440
15	108	216	432	540	1080	2160
25	180	360	720	900	1800	3600
50	360	720	1440	1800	3600	7200
75	540	1080	2160	2700	5400	10800
100	720	1440	2880	3600	7200	14400
150	1080	2160	4320	5400	10800	21600
200	1440	2880	5760	7200	14400	28800
300	2160	4320	8640	10800	21600	43200
400	2880	5760	11520	14400	28800	57600
600	4320	8640	17280	21600	43200	86400
800	5760	11520	23040	28800	57600	115200

The Duncan Meter.

The formula for testing meters manufactured by the Duncan Electric Manufacturing Company is

$$P = \frac{R \times K \times 3600}{t}$$

which is the same as that previously given for the General Electric meter. The following is a table of testing constants:

	110 Volts		220 Volts		550 Volts	
Amps.	Meter "K"	Watts per r.p.m.	Meter "K"	Watts per r.p.m.	Meter "K"	Watts per r.p.m.
2.5	0.25	15	0.5	30	1	60
5	0.25	15	0.5	30	1	60
7.5	0.50	30	1	60	2	120
10	0.50	30	1	60	2	120
15	1	60	2	120	5	300
25	1	60	2	120	5	300
50	2	120	4	240	10	600
75	3	180	6	360	16	960
100	4	240	8	480	20	1200
150	6	360	12	720	30	1800
200	8	480	16	960	40	2400
300	12	720	25	1500	60	3600
450	20	1200	30	1800	80	4800
600	25	1500	50	3000	100	6000
800	30	1800	60	3600	160	9600

Sometimes it is necessary to use the formula already given for the determination of other values than the watts, P, and for convenience this formula is rewritten as follows:

(1) $\text{Number of revolutions} = \frac{\text{Secs. during test x watts indicated}}{\text{3600 x testing constant (K)}}$

(2) $\text{Testing constant} = \frac{\text{seconds during test x watts indicated}}{\text{3600 x revolutions.}}$

(3) $\text{Seconds} = \frac{\text{3600 x revolutions x testing constant}}{\text{watts indicated}}$

The Sanmango Mercury Meter.

A description of the Sangamo Mercury Meter will be found in Chapter V., the table of calibrating constants being given below:

Amps.	100/125 volts.	200/250 volts.	500/600 volts.
5 A. C.	1,800	3,600	....
5 D. C.	2,400	4,800	12,000
10	2,400	4,800	12,000
20	4,800	9,600	24,000
30	7,200	14,400	36,000
40	9,600	19,200	48,000
60	14,400	28,800	72,000
80	19,200	38,400	96,000
100	24,000	48,000	120,000
150	36,000	72,000	180,000
200	48,000	96,000	240,000
300	72,000	144,000	360,000
400	96,000	192,000	480,000
500	120,000	240,000	600,000
600	144,000	288,000	720,000
800	192,000	384,000	960,000
1000	240,000	480,000	1,200,000

The calibrating equation for the Sangamo is the same as for the Westinghouse meter, viz.:

$$P = \frac{R \times K}{t},$$

in which the constant, K = watt-seconds recorded by one revolution of the disc.

Larger capacity meters than given in the above table have proportionally greater values of K.

Three wire 110-220 volts A. C. meters have same constants as above given for the 200-250 volt meters.

Testing with the Portable Rotating Standard.

The third method of testing watthour meters, and probably the most convenient and the quickest for outside work, consists in using a portable standard watt hour meter, which is usually known as a "rotating standard." It is especially well adapted for the rapid testing of service meters at the point of installation. The portable standard eliminates the necessity of a stop watch, since the time element does not enter into account; furthermore, the load does not have to remain constant during the test, as is the case with both of the previously named methods; the only thing which has to be observed is the number of revolutions of the disc of the meter under test; the disc of the rotating standard is directly connected to the large or lowest reading pointer, and therefore indicates the actual number of revolutions which it makes. Figure 89 shows interior and exterior view of a typical type of rotating standard test meter. This type of meter is essentially an ordinary watthour meter with certain modifications. It is made with several different current coils whose leads are brought out to a connection block on the top of the meter or to a drum switch within, and that coil whose capacity is nearest the value at which the meter under test is operating can be connected in the circuit. By this means the test meter can always be made to operate at or near full load, therefore having its full load accuracy throughout a wide range. This is an excellent feature, as it insures accuracy over a wide range and also permits the use of one test meter for calibrating watthour meters of various sizes.

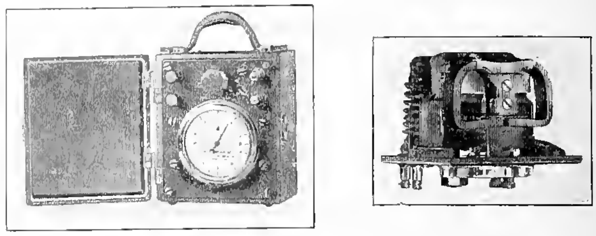


Fig. 89.

The rotating standard is made self-contained in the following sizes: Direct current, 110-220 volts, with current coils for 1, 2, 10, 20 and 40 amperes, or with current coils for 5, 10, 50 and 100 amperes; alternating current, 110-220 volts, with current coils for 1, 10 and 20 amperes, or with current coils for 1, 5, 10, 50 and 100 amperes. By means of "multipliers" or potential transformers, these instruments can be used on 440 and 550 volts.

The rotating standard is very carefully designed and is well built mechanically. The registering mechanism is simple, since, as previously stated, the disc shaft is directly connected to the lowest reading pointer. The complete dial is usually made up of two pointers, the ratio being such that the highest reading pointer will not repeat its reading within less time than about two and one-half minutes when operating at full load speed. The number of revolutions of the disc as indicated by the pointers, multiplied by the constant for the particular coil of the standard which is connected in circuit, gives the watt hours that have passed during the time it is connected to the circuit, or

$P = R \times K$ (Gen. Elec. Rotating Standard).

The accuracy of the meter under test is expressed by the following equation:

$$\text{Percentage of accuracy} = \frac{r \times k}{R \times K} \times 100, \text{ where}$$

r=revolutions of disc of meter under test;
k=constant of meter under test;
R=revolutions of rotating standard as indicated by register;
K=constant of coil being used in standard.

For General Electric meters, k is marked on the disc.

$$\text{For Westinghouse meters, } k = \frac{c \times \text{watt rating}}{3600},$$

where c is the value of the constant for Westinghouse meters.

For Fort Wayne meters, $k = \frac{c}{36}$, where "c" is the value of the constant as given for Fort Wayne meters.

In the case of the rotating standard, the value of the constant K for the individual coils is the same as in the standard service meters. For instance, the value of K for the 10-ampere coil in the rotating standard is the same as the constant for a 10-ampere service meter, so that when testing service meters with a rotating standard and at the same time using the coil of the standard meter which is of the same capacity as the meter under test, is is only necessary to compare the revolutions of the two meters, that is:

$$\text{Percentage of accuracy} = \frac{r}{R} \times 100, \text{ or the}$$

$$\text{Percentage of error} = \frac{r - R}{R} \times 100, \text{ where}$$

r=revolutions of the meter under test, and R= revolutions of standard.

Below is given a table of data to be used with the Westinghouse rotating standard when used in checking induction meters manufactured by the Westinghouse Company, the General Electric Company and the Fort Wayne Electric Works:

Service Meter.	Revolutions		Stand Meter	Revolutions of Westinghouse Rotating Standard for 94% to 106% Registration of Service Meter												
Cap. Amps.	Heavy Load	Light Load	Cap. Amps.	94 %	95 %	96 %	97 %	98 %	99 %	100 %	101 %	102 %	103 %	104 %	105 %	106 %
*Westinghouse—Types "B" and "C"																
5 10 20 40	25 25 25 25	... ...	5 10 20 40	26.6	26.32	26.04	25.77	25.51	25.25	25.00	24.75	24.51	24.27	24.04	23.81	23.58
5 10 20 40	... ...	1.0 1.0 1.0 1.0	5 10 20 40	1.06	1.05	1.04	1.03	1.02	1.01	1.00	0.99	0.98	0.97	0.96	0.95	0.94
80 80	15 ...	... 1.0	40 40	31.91 2.13	31.58 2.11	31.25 2.08	30.93 2.06	30.61 2.04	30.3 2.02	30.0 2.0	29.70 1.98	29.41 1.96	29.13 1.94	28.85 1.92	28.57 1.90	28.30 1.89
General Electric—Type "I."																
3 3	30 ...	... 2.0	5 5	19.15 1.28	18.95 1.26	18.75 1.25	18.56 1.24	18.37 1.22	18.18 1.21	18.00 1.20	17.82 1.19	17.65 1.18	17.48 1.17	17.31 1.15	17.14 1.14	16.98 1.13
5 10	30 30	... ...	5 10	28.72	28.42	28.13	27.84	27.55	27.27	27.00	26.73	26.47	26.21	25.96	25.71	25.47
5 10	... ...	2.0 2.0	5 10	1.92	1.90	1.88	1.86	1.84	1.82	1.80	1.78	1.77	1.75	1.73	1.7	1.70
15 15	30 ...	... 2.0	20 20	23.93 1.60	23.68 1.58	23.44 1.56	23.20 1.55	22.96 1.53	22.75 1.52	22.50 1.50	22.28 1.49	22.06 1.47	21.84 1.46	21.63 1.44	21.43 1.43	21.23 1.42
25 50	30 30	... ...	20 40	35.90	35.53	35.16	34.80	34.44	34.09	33.75	33.42	33.09	32.77	32.45	32.14	31.84
25 50	... ...	2.0 2.0	20 40	2.39	2.37	2.34	2.32	2.30	2.27	2.25	2.23	2.21	2.18	2.16	2.14	2.12
Fort Wayne—Type "K"																
5 10 40	30 30 30	... ...	5 10 40	23.93	23.68	23.44	23.20	22.96	22.73	22.50	22.28	22.06	21.84	21.63	21.43	21.23
5 10 40	... ...	2.0 2.0 2.0	5 10 40	1.60	1.58	1.56	1.55	1.53	1.52	1.50	1.49	1.47	1.46	1.44	1.43	1.42
25 50	30 30	... ...	20 40	23.93	23.68	23.44	23.20	22.96	22.73	22.50	22.28	22.06	21.84	21.63	21.43	21.23
25 50	... ...	2.0 2.0	20 40	1.60	1.58	1.56	1.55	1.53	1.52	1.50	1.49	1.47	1.46	1.44	1.43	1.42

It is recommended that test be made at approximately 100% and 4% of full load, if loads are within range of standard meter. Load service meter so as to give revolutions stated in table, in approximately one minute.

* Westinghouse Round Pattern and Type "A" meters should make fifty r.p.m. at full load. Speeds given are for 100 and 110 volt meters. If 200, 220 volt meters are tested, use 200 volt coil of standard meter, and speeds still apply. This data is not applicable to General Electric 40 cycle, Type "I" meters.

Fig. 90.

The constant of any coil of the Westinghouse rotating standard is the same as the constant of a Westinghouse service meter having the same ampere capacity as that coil, so that the meter under test and the standard should make the same number of revolutions if the meter under test is correct.

The general connections of the test meter are shown in Figure 91. After the connections have all been made the meter is started and stopped by simply closing or opening the little push button switch, S. The meter tester has only to close the potential circuit by means of this switch, note the number of revolutions made by the standard and by the meter under test and apply these values in the above formula, from which he can immediately obtain the percentage accuracy of the meter under test. If it is found to be too fast or too slow it should be adjusted as previously explained. Meters should be adjusted for accuracy both on full load and about 5 per cent load, and it should be within 2 per cent correct throughout this range.

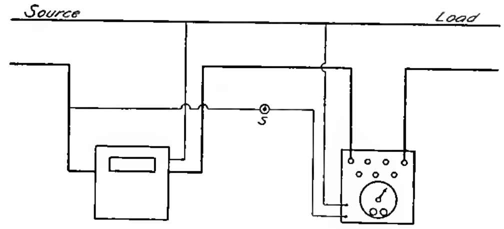


Fig. 91.

In using a portable rotating standard it should be remembered that it must be calibrated from time to time by checking it against laboratory standards.

When testing meters at the point of installation it is usually more convenient to have some kind of a "portable load," which will consist of a lamp bank or other resistance suitably mounted so that it may be carried from place to place, rather than to use the customer's load for testing purposes. With the "portable load" the tester can do his work quicker and he can get the exact load which he desires to put on the meter under test.

(To be continued.)

N. A. S. E. CONVENTION.

The seventh annual convention of the California State Association, N. A. S. E., together with an engineering and mechanical exhibit, will be held in Los Angeles, Cal., May 23 to 28, 1910. The meetings will be held in the Hamburger Building, on Eighth street, between Hill and Broadway, and the headquarters will be maintained at Angelus Hotel.

Meeting Place for N. A. S. E., Los Angeles Convention.

Full details as to the plans for the meeting will appear in our issue of May 21st. Every indication points to a large and an enthusiastic gathering and we believe that all engineers will profit by attending the meetings.

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POWER AND GAS

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Oil Gas Versus Steam

To pit an automobile against a mule on a mountain trail is as inconclusive of their relative merits as to compare a gas engine with a steam turbine under the premises assumed on another page by Mr. A. M. Hunt. Every prime mover is circumscribed by certain limitations. Here they include the fuel used, the locality and the special design necessary for emergency service.

The steam turbine plant proposed has the advantage of a splendid heritage, the experience of centuries. It is equipped with many devices suggested by engineering ingenuity, including heat storage and internal electric heaters. Figueratively it may be said to have a college education, whereas the gas engine is not out of the primary school.

This hypothetical steam turbine installation is compared with a pioneer gas engine plant that was built before many of the present refinments of steam engineering, and also gas engine practice, were available. The gas engines at Martin were built without precedent and have been the horrible example by which all subsequent engines have profited.

Mr. Hunt's figures show that both the first cost and the stand-by charges of his steam turbine plant would be less than half that of an oil gas engine plant of the same capacity. One can be put on the line as soon as the other and each has about the same efficiency, closely approximating one brake horsepower per pound of oil. He conclusively proves his contention that the steam turbine is the better for emergency service with oil fuel on the Pacific Coast.

Elsewhere it is otherwise. With the low-grade fuel utilized in some of the Eastern gas producers or with blast furnace gases the steam turbine would make as poor a showing as an automobile on a diet of thistles, the stand-by of the omnivorous jackass. Oil gas made by the Jones' process is too rich for the gas engine. It has a relatively high and perhaps inconstant percentage of hydrogen. This variable excess of hydrogen ratio is one of the causes of pre-ignition, for hydrogen, like nitro-glycerine, explodes suddenly. Carbon-monoxide, the other dynamic constituent of the gas, like black powder, burns more slowly. Ordnance experts have demonstrated that a slow burning powder, whose expansive force is continuously exerted on the bullet until it leaves the gun, not only gives greater velocity to the bullet, but also saves the gun. Likewise, a lean and slow burning gas gives the best results in an engine.

Other oil-gas processes have been devised, notably the Nix-Frost producer and the Amet-Ensign type, which show a lower hydrogen content. As yet these have been tried out in plants of but hundreds, where the Martin units are of thousands of horsepower. The engineer in the capacity of judge and not advocate will therefore withhold his decision until more data is available.

PACIFIC COAST MEETING A. I. E. E.

The first Pacific Coast meeting of the American Institute of Electrical Engineers was called to order in San Francisco by President Lewis B. Stillwell at 11 a. m. Thursday, May 5, 1910, with a registered attendance of one hundred and fifty. After a few opening remarks by President Stillwell, Secretary Pope made a number of announcements. An address of welcome to the visiting members was made by Professor Harris J. Ryan of Stanford University, local member of the High Tension Committee. In reply to this address, President Stillwell traced the growth of the Institute since its inception and dwelt upon a number of special problems that have recently presented themselves, including that of technical sections and the necessity for distant members participating in the general meetings. Judging from the success of the Charlotte, N. C., meeting and that in San Francisco, he concluded that the holding of such meetings under the auspices of any one of the six special committees has satisfactorily solved both these problems.

Mr. G. I. Rhodes, assistant engineer of the Interborough Rapid Transit Company of New York City, briefly discussed his paper on "Parallel Operation of Three-phase Generators With Their Neutrals Interconnected." In this paper he developed a mathematical explanation for the triple harmonic that has been found to interfere with synchronizing three-phase, star-connected generators with their neutrals in parallel. To obviate this difficulty the author suggested that either the windings be so distributed over 120 degrees of space that no third harmonic potentials would be generated, or that the generator be designed with a uniform air-gap so that the distribution of the armature reaction flux will be the same as that of the magnetomotive force. In the discussion that followed it was questioned whether the third harmonic causes sufficient trouble to make the suggested changes in generator design advisable. In a contributed discussion, Mr. P. M. Lincoln attributed much of this trouble to the reciprocating engines. The discussion also included remarks on the advantages and disadvantages of grounding the neutral.

On Thursday afternoon Mr. P. M. Downing read his paper on "The Developed High Tension Network of a General Power System" as published in these columns on May 7, 1910. The interesting discussion which ensued will be published in these columns as soon as available.

On Friday morning, May 6, Mr. J. J. Frank's paper on "Observation of Harmonics in Current and Voltage Wave Shapes of Transformers" was abstracted and explained by Mr. G. Faccioli of Pittsfield, Mass. This paper shed much light on the hitherto little understood effect of the third harmonic on transformers. An interesting and valuable discussion followed, in the course of which Professor C. L. Cory suggested that this third harmonic which seems to be giving so much trouble may at some future period prove a most useful factor in reducing transmission line troubles.

On Friday afternoon Mr. A. H. Babcock read his paper on "Transmission Line Crossings of Railroad Rights of Way" as printed in this Journal May 7, 1910. During the course of the discussion several interesting types of protectors were discussed and the recommendation made that the proposals embodied in Mr. Babcock's paper be used as a basis for a standard agreement between the power companies and the railroads.

Later in the afternoon Mr. John Coffee Hays read an extended paper on "Hydro-Electric Development and Irrigation;" the facts and figures being based upon the operation of the Mount Whitney Power Company's system in Southern California. The discussion brought out more detailed figures of cost than were given in the paper, which will be published in an early number of the Journal.

On Saturday morning Mr. A. M. Hunt read a paper on "Emergency Generating Stations for Service in Connection With Hydro-Electric Transmission Plants Under Pacific Coast Conditions," as published in this number.

After a number of resolutions had been adopted and a cablegram of condolence regarding the death of King Edward sent to the British institution of Electrical Engineers, the meeting adjourned.

During the technical sessions the ladies accompanying the visiting members were entertained at various teas, theatre parties and sight-seeing trips.

On Thursday evening the visiting members were entertained by the local executive committee at a dinner at the Bohemian Club. On Friday evening a subscription banquet at the Poodle Dog was attended by about seventy members. Mr. S. J. McMeen presided as toastmaster in his usual brilliant fashion, calling in turn upon President Stillwell, Secretary Pope, W. W. Briggs, A. H. Babcock and A. M. Hunt.

On Saturday afternoon a large number visited Stanford University at the invitation of Professor Harris J. Ryan, who gave a lecture and experimental demonstration of his cathode ray power indicator, an instrument that produces diagrams of power present in high tension circuits, the corona volt meter, which indicates the maximum values of high alternating pressure and of the pressure surges, and the cathode ray indicator, which shows pressure and current wave forms in alternating current arc light and also the harmonics. The exhibition of these instruments excited great interest among those present, who felt amply repaid for the trip.

Many took the opportunity to visit the local power plants near the vicinity of San Francisco Bay while here, and on Sunday night a party of visiting members started on a trip of inspection over the lines of the Pacific Gas & Electric Company, the Great Western Power Company and the Northern Electric Railway Company, returning on Wednesday of this week. The list of those registered at the meeting is as follows:

Markham Cheever, Provo, Utah; H. T. Cory, Los Angeles; G. Faccioli, Pittsfield, Mass.; John B. Fisken, Spokane, Wash.; Victor H. Greisser, Spokane, Wash.; F. V. Henshaw, New York; Jno. Harisberger, Seattle, Wash.; Fred Hamilton, Visalia, Cal.; John Coffee Hays, Visalia, Cal.; Paul Lebenbaum, Portland, Ore.; H. W. Pudan, Carmel, Cal.; E. W. Paul, Upland, Cal.; Ralph W. Pope, New York City; W. E. Rundle, Orange, N. J.; Geo. I. Rhodes, New York; L. J. Scattergood, Pasadena, Cal.; Lewis B. Stillwell, Lakewood, N. J.; Frank R. Schalch, Chicago, Ill.; W. F. Wells, Brooklyn, N. Y.

Local—G. E. Anderson, Thos. Anderson, R. H. Atkinson, Wyatt H. Allen, C. F. Adams, R. M. Alvord, R. S. Buck, B. B. Beckett, F. L. Baer, C. W. Burkett, Orrion Brooks, Frank Barry, A. J. Bowie, Jr., Henry Bosch, J. P. Bradner, Geo. H. Bragg, A. H. Babcock, H. W. Crozier, B. C. Condit, C. L. Cory, P. O. Crawford, S. K. Colby, Clem A. Copeland, H. W. Clapp, S. B. Charles, Jr., W. F. Drake, W. J. Davis, Jr., R. Dolson, K. G. Dunn, W. A. Doble, P. M. Downing, J. G. De Remer, A. B. Domonoske, R. Deakin, F. Marion Edwards, E. G. Elliott, J. J. Ferrier, L. J. McFarland, H. P. Finnigan, Otto E. Falch, Jr., Donald H. Fry, S. G. Gassaway, R. H. Gerard, A. M. Griswold, C. F. Gilcrist, C. A. Gaines, C. W. Hutton Albert L. Harris, J. O. Hansen, H. M. Hall, H. Homberger, A. S. Heyward, C. S. Hall, W. W. Hanscom, John Hood, H. Y. Hall, A. M. Hunt, A. H. Halloran, S. W. Herr, W. A. Hillebrand, A. B. Johns, Louis F. Johnson, Geo. S. Johnson, Lars Jorgensen, J. P. Jollyman, Allen G. Jones, G. I. Kinney, Wm. R. Keyes, M. C. Lord, Thos. D. Lewis, H. A. Laidlaw, Douglas Lindsay, S. J. Lisberger, W. F. Lamme, F. V. T. Lee, C. A. Lozier, W. C. Myers, Wynne Meredith, G. R. Maxwell, F. E. Manzin, E. H. Mallory, W. C. Miller, Jr., Chas. K. Miller, Elam Miller, R. W. Mastick, Jr., George R. Murphy, S. G. McMeen, H. R. Noack, L. Nott, P. F. Orra, R. W. Pinger, R. Page, L. M. Perin, J. J. Pottinger, E. K. Preston, H. C. Parker, C. E. Rogers, L. Rehfuese, M. Rhine, C. E. Sedge-

wich, G. C. Rohb, Harris J. Ryan, L. H. Somers, B. C. Shipman, R. E. Stevenson, F. H. Searight, F. O. Sievers, E. M. Sweitzer, E. O. Shreve, H. E. Shedd, Wm. G. Stearns, W. D. Scott, Geo. H. Scoville, Sidney Sprout, A. B. Saurman, L. E. Torrey, A. J. Theis, Frank T. Vanatta, Rudolph Van Norden, Max Vestat, W. G. Vincent, Jr., J. Wicks, C. J. Wilson, C. M. Weymann, C. A. Weymouth, Geo. C. White, Clarence Wortman, J. W. White, G. B. Wright, Henry N. Young, John F. Rhame.

PERSONALS.

A. M. Hunt is in Portland.

W. A. Purcell is now in the employ of the Great Western Power Company.

F. T. Robson, of Spalding, Sloan & Rohson, engineers, is at Newman, Cal., supervising a hydraulic contract.

C. E. Johnson is now general manager of the United States Electric Manufacturing Company of Los Angeles, Cal.

Sidney M. Stone, of Hall, Demarest & Co., has returned to Virginia City, Nev., after visiting the San Francisco office.

A. C. Balch, general manager of the Pacific Light & Power Company of Los Angeles, was in San Francisco this week.

A. W. Vinson, engineer for the Cutler-Hammer Manufacturing Company's Pacific Coast office, is in Los Angeles on business.

Thomas Mirk, of Hunt, Mirk & Co., representing the Westinghouse Machine Company on the Pacific Coast, has been in San Diego.

C. A. Tupper, formerly publicity manager of the Allis-Chalmers Company, has opened an engineering-contracting office in San Francisco.

J. P. Bradner, until recently with the San Francisco office of the Fort Wayne Electric Works, is now with Pierson Roeding & Co. of San Francisco.

Paul Shoup, vice-president in charge of electric lines of the Southern Pacific Company, returned to San Francisco from Los Angeles during the past week.

John R. Freeman of Providence, Rhode Island, is at Vancouver, B. C., inspecting the site of the proposed dam of the Vancouver Power Company at Lake Coquitlam.

G. P. Jones, manager of the Western hranch of the American Electric Fuse Company of Muskegon, Wis., is making an extended trip throughout the Northwest.

J. W. Hewitt has been appointed trainmaster of the Oregon Water Power Division of the Portland Railway, Light & Power Company, of Portland, to succeed S. P. Jones, resigned.

G. B. Shipley, chief engineer of the Allis-Chalmers Company's mining department, was in San Francisco during the past week. He is a native of California and was formerly connected with the Union Iron Works.

B. T. Longino, of the transportation department of the Seattle (Wash.) Electric Company, has heen appointed assistant to Mr. F. A. Boutelle, superintendent of transportation of the Tacoma Railway & Power Company, Tacoma, Wash.

George R. Field, assistant manager of the Great Western Power Company, left last Monday for a trip to the company's power station at Big Bend, which was inspected during the week by a number of visiting electric engineers from Eastern and Pacific Coast cities.

L. H. Bean, manager of the Whatcom County Railway & Light Company, Bellingham, Washington, has been appointed manager of the Puget Sound Electric Railway, Pacific Traction Company and the Tacoma Railway & Power Company, Tacoma, to succeed W. S. Dimmock.

Henry W. Butler, resident engineer at Los Angeles, for J. G. White & Co., engineers, is visiting the company's San Francisco office this week. He has engineering supervision of the erection of two 12 000 kw. steam turbine generating sets for the Pacific Light & Power Company at Redondo.

Wynn Meredith of Sanderson & Porter's San Francisco office, returned last week from a trip to Vancouver Island, where his company is installing a power plant on the Jordan River for the British Columbia Electric Railway Company. Mr. Meredith was one of the electrical engineers who visited the Great Western Power Company's plant at Big Bend.

M. C. McKay, superintendent of the Stanislaus power station of the Sierra and San Francisco Power Company, has been in San Francisco in connection with starting up of the new Stanislaus transmission line. Mr. McKay is in charge of the operation of the power plant from the headwaters to the end of the 135-mile transmission line at San Francisco.

TRADE NOTES.

A. P. Eldred has been appointed Pacific Coast representative of the Brilliant Electric Company of Cleveland, Ohio, maintaining offices in the Mouadnock building, San Francisco.

The Chicago Battery Company has been succeeded by the Vivax Storage Battery Company, 2228 Michigan Boulevard, Chicago, in the manufacture of the Duro line of storage batteries for automobile ignition and lighting.

The Los Angeles Gas & Electric Corporation has placed an order with Allis-Chalmers Company for three more 500 K. V. A. oil-filled, self-cooled transformers and three additional 500-kw. oil-filled water-cooled transformers.

The Cutler-Hammer Manufacturing Company of Milwaukee will hereafter manufacture and market for Kohler Brothers of Chicago in the United States and Canada, the various types of push-hutton operated controllers comprised in "The Kohler System" of control and its application to printing presses and other classes of motor-driven machinery.

Two Westinghouse low-pressure steam turbines, each having a capacity of 500 kw., have been added to the power plant of the Standard Steel Car Company at Burnham, Pa. These turbines utilize the waste steam of the main equipment, and are designed for a vacuum of 28 inches, which will be provided by Westinghouse-Leblanc condensers. The energy thus conserved is applied to two 500 kw. generators which furnish light and power for the shops.

The Pelton Water Wheel Company has an order from the Braden Copper Co. in Chili for turbine wheels aggregating about 13,000-hp. for a hydroelectric transmisison plant for their mines. There will be three 4000-h.p. Pelton-Francis turbines operating under a head of 420 feet at 600 r.p.m. Pelton oil pressure governors will be used. The contract includes also three exciter-turbines with fly wheels. Owing to the great amount of work in the San Francisco plant this contract will be fulfilled at the Pelton Water Wheel Company's eastern works.

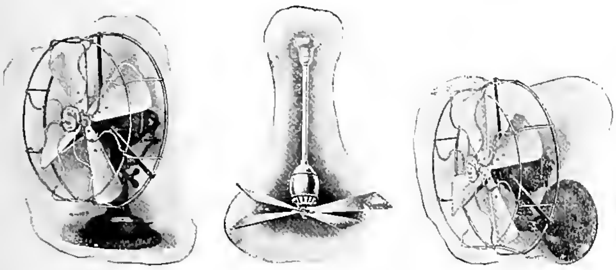
GAS-ELECTRIC MOTOR CARS.

Those connected with railway work will be interested in the attractive pamphlet recently issued by the General Electric Company, describing the single truck type of gas-electric motor car. The equipment consists of a direct coupled gas-engine and generator with an exciter on the same shaft, all completely inclosed and mounted between the axle of the truck and below the car floor, so that the interior of the car is entirely unobstructed. The operation is similar to that of an ordinary trolley car, and the car can be operated in either direction with equal facility. The car, motor, and engine are illustrated and described in Bulletin No. 4730, which contains also a table of schedule speeds for this car.

INDUSTRIAL

SPRAGUE ELECTRIC FANS FOR 1910.

There is every indication that the fan business this year will be unusually large and the dealers should be prepared to take advantage of an early demand. No time should be lost in getting catalogues and prices and in making contracts to insure prompt deliveries. The well known line of fans manufactured by the Sprague Electric Company is better than ever this season and also covers a wider range of types. The new types are the 8-inch hinge joint desk and bracket fans, the 8-inch telephone booth fans and the midget ceiling fans. The Midget ceiling fan has a sweep of blades of only 32 inches and can be used in many places where the full-sized ceiling fan would be out of place. It is also furnished in white enamel, including the blades, so that it is an extremely ornamental fan. Though on the market but a short time, many of them have been sold.



Sprague Electric Fans.

The desk and bracket fans this year have been improved by making the guard better and stronger. It is light and very durable. The standard or base of these fans have also been improved and simplified. It is no trick to change the non-oscillating universal joint fan into an oscillating fan.

The Sprague Electric Fans always have had a ready sale because of their excellence in design and construction. Dealers know that the Sprague Fans please the customers. The customer knows that if he has a Sprague Fan he can enjoy it without worrying about the current consumed or the possible need of repairs. Both items are reduced to the minimum. Sprague Fans displace a large amount of air, run quietly, require practically no attention and last indefinitely. Full description of these fans is contained in the 1910 catalogue No. 32154, a copy of which may be obtained by addressing such request to the Sprague Electric Company, New York City.

NEW CATALOGUES.

Booklet 5022, from the Fort Wayne Electric Works, lists various styles of a.c. and d.c. Fort Wayne Fan Motors for 1910, giving a brief description and price of each type.

Bulletin No. 389, from the National Brake & Electric Company, illustrates and describes various types of National emergency and variable release valves for use with the air brake operation of electric railways.

The high efficiency of the Mazda lamp makes it a competitor in the lighting of larger areas, and in order to equip it so as to meet these conditions most effectively, the Mazda Economy Diffuser has been designed. The special advantages of this diffuser are wide range of capacity, relatively low intrinsic brilliancy with excellent diffusion, and economical distribution of light. Bulletin No. 4729, recently issued by the General Electric Company, illustrates and describes the various designs of diffusers.

GRINDING AND BUFFING EQUIPMENTS.

The General Electric Company's new and improved types of alternating current buffing and grinding equipments are designed for use in wood working, machine and repair shops, foundries, large manufacturing establishments, etc., where alternating current is available. These devices find a ready application for dressing small castings, accomplishing the work much more quickly, and giving a finer finish than can be obtained with machine tool, chipping hammer, chisel, etc.

The grinding equipment consists of an alternating current motor with substantial supports fitted with tool rest and water attachment; these latter accessories being rigidly clamped to the bearing brackets in such manner as to permit ready removal when desired. Each end of the extended shaft is fitted with two steel flanges, two leather washers, and one nut for clamping the emery wheel securely in position. The motors are rendered splash and dust-proof by totally enclosing them; while shafts, bearings, attachments and all working parts are made extra strong and durable to withstand hard and constant usage.

The installation of a General Electric grinding equipment, where it is readily accessible to the shop force, enables the men to always keep tools sharp, thereby saving time, greatly increasing output and improving the quality of the finished product. As sharp tools require much less power to operate than dull ones, the cost of power may be sensibly diminished by keeping all cutting edges in the best condition. Workmen using dull tools are apt to become careless and eventually turn out inferior work, resulting, especially where competition is keen, in loss of the shop's prestige and patronage.

These self-contained, compact and rugged buffing equipments provide a very effective polishing device, the use of which invariably results in a great saving of time and labor. These devices are similar in construction to the grinding outfits with the exception that tool and water attachments are omitted. The shaft is also longer, each end being tapered and threaded for receiving the buffs. The bearing brackets are circular and so designed that they may be turned through 90 degrees to admit of side wall installation, thus allowing relocation of the device at will.

The following equipments may be supplied for operation on single, two or three phase, 110/220 volt circuits: Single phase, 3/8, 1, 2 and 3 h.p.; polyphase, 3/8, 1, 2, 3, 5 and 7½ h.p.

WESTINGHOUSE COMPANIES GET IRRIGATION ORDER.

The Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., has recently entered an order for two 600-kw. alternating current generators, to be installed in connection with the work of the Portales Irrigation Company, Portales, N. M. The Westinghouse Machine Company will make the gas engines to drive these and will also furnish three 500-hp. bituminous gas producers. The generators will develop a three-phase, 60-cycle, 2,300-volt current which will be stepped up to 11,000 volts. At the sub-stations this will be reduced to 440 volts.

In connection with this irrigation project, 72 motor-driven pumps will take water from wells, 30 to 50 ft. deep, and deliver it to the farms in the surrounding territory. Through their combined efforts many thousand acres will be made productive. The Western Construction Company of Wichita, Kans., has the contract for the construction work. It is expected that the cost of water per foot-acre supplied by the system will be sufficiently low to make it commercially practicable to reclaim hundreds of thousands of acres of similarly arid lands.

APPROVED ELECTRICAL DEVICES

ATTACHMENT PLUGS, FUSELESS.

Edison Type, 3 A. 250 V. Composition (weatherproof) Cat. No. 1151. Approved March 1, 1910. Manufactured by

C. S. Knowles, 7 Arch St., Boston, Mass.

CONDUIT BOXES.

"S. E. Co." For Rigid Conduit: Cast Iron, Cat. Nos. 2520, 2521, 2525 and 2526. Stamped Steel, Cat. Nos. 6200, 6200 straight electric, 6219-6222 incl., 6225, 6225 deep, 6231, 6231 deep, 6249, 6250, 6300, 6350, 6350 deep, 6350 N, 6399, 6399 deep and 6400. For Flexible Steel Conduit or Steel Armored Conductors: Cat. Nos. 1904, 1905, 6236-6239 incl. and Cat. No. 6240 with fibre flange. Junction Boxes: Cast Iron, Cat. Nos. 2504-2514 incl., lined or unlined. Covers of stamped steel, cast iron or porcelain suited for above boxes. Approved March 4, 1910. Manufactured by

Sprague Electric Co., 527 W. 34th St., New York, N. Y.

"FA" Surface Receptacle Holders. Type for use as an outlet for FA Post Office floor or wall boxes. Type for use with rigid conduit. Approved only for exposed work March 4, 1910. Manufactured by

Frank Adam Electric Co., 904-914 Pine St., St. Louis, Mo.

CONDUIT BOXES, FLOOR OUTLET.

"Fountain" cast-iron floor boxes for use with rigid conduit; with brass cover plates and outlet nozzles. Cat. Nos. 250 and 260. Approved Feb. 28, 1910. Manufactured by

John Fountain, Jr., No. 28 Orange St., Newark, N. J.

CONDUIT OUTLET BUSHINGS AND COUPLINGS.

"Monitor." Galvanized steel bushings for rigid unlined conduit. Marking is B. "Erickson" insulated outlet bushings. Approved March 4 1910. Manufactured by

Bossert Electric Construction Co., Utica, N. Y.

GROUND CLAMPS.

"All-in-One" clamp for flexible or rigid conduit or for armored cable. Copper strap with clamps and bolts and having lugs into which connecting wires are to be soldered. "Vogel" clamp for signal systems only. A half-inch soft copper band heavily tinned, and brass clamping device. Approved Feb. 16, 1910. Manufactured by

Fairmount Electric Mfg. Co., 2320 Market St., Philadelphia, Pa.

LAMP GUARDS.

"Morse," Cat. No. 26, Portable Handle and Guard. Approved Feb. 28, 1910. Manufactured by

Frank W. Morse, 516 Atlantic Ave., Boston, Mass.

RECEPTACLES, STANDARD.

"G. E." Key and Keyless Types. Wall Sockets, Brass Shell. Key Cat. Nos. 9184, 27742, 28721 (slotted or closed base), 29404, 29406, 50753, (slotted or closed base) and 60018 also 88959 (for use on metal ceilings). Keyless Cat. Nos. 9185, 27743, 28722, 29405, 29407, 50755, 60019, and 60020, also 88960 (for use on metal ceilings). Porcelain Shell, keyless, 3 A., 250 V. Cleat Type, Cat. Nos. 11221, 28794, 28795, 50715, 59275 and 61039. Concealed Type., Nos. 49355, 50717, 50744. Also 50752, fused, 2 A., 125 V. Moulding Types, Nos. 34152 and 42453. Conduit Box Nos. 9514, 9397, 40537, 49354, 60931 and 62357. Sign Receptacle, No. 46627. Approved March 1, 1910. Manufactured by

General Electric Co., Schenectady, N. Y.

"Paiste" Key and Keyless types. Wall Sockets, Brass shell. Key Cat. No. 9184. Keyless Cat. Nos. 9185 and 60019. Approved March 1, 1910. Manufactured by

H. T. Paiste Co., 32d and Arch Sts., Philadelphia, Pa.

RHEOSTATS.

"Allen-Bradley" Battery Charging Rheostat, Type H, 3000 watts, 110 Volts. Approved (for switchboard mounting only) February 26, 1910. Manufactured by

American Electric Fuse Co., Muskegon, Mich.

SWITCH BOXES.

"S. E. Co." For flexible steel conduit or steel armored conductors: Cast iron, Cat. Nos. 3001-3006 incl., lined or unlined, 5950, 5951, 5971-5978 incl., and 5991-5998 incl. Approved March 6, 1910. Manufactured by

Sprague Electric Co., 527 W. 34th St., New York, N. Y.

SWITCHES, KNIFE.

Type C, 30 A. 250 V. Single, double and four pole, and three-wire punched clip switches, mounted on slate bases. With or without N. E. Code standard cartridge enclosed fuse extensions. Approved February 25, 1910. Manufactured by

New Haven Electric Mfg. Co., North Haven, Conn.

SWITCHES, PENDANT SNAP.

"Perkins" 2 button types, single pole, 10 A. 125 V., 5 A. 250 V.; double pole, 10 A. 250 V. Single button types, 3-way, 5 A. 250 V., 10 A. 125 V. Electrolier and 4-point, 2 A. 250 V., 5 A. 125 V. Fan Motor Switches, 5 A. 250 V., 10 A. 125 V. Approved Feb. 16, 1910. Manufactured by

Perkins Electric Switch Mfg. Co., Bridgeport, Conn.

SOCKETS, MINIATURE.

Miniature and Candelabra Sockets, ½ A., 125 V. Pendant, Cat. Nos. 322 and 323. Brass Shell, Cat. Nos. 320 and 321. Candelabra Candle Socket, Cat. Nos. 328 and 347. Approved for use in connection with porcelain candle. Approved March 17, 1910. Manufactured by

The Bryant Electric Co., Bridgeport, Conn.

SOCKETS, WEATHERPROOF.

"Freeman" porcelain shell bracket keyless, 3 A., 250 V. Cat. Nos. 155, 156, for ⅛ in. or ⅜ in. pipe. Approved (for use where not exposed to hard usage) March 15, 1910. Manufactured by

E. H. Freeman Electric Co., Trenton, N. J.

SWITCHES, SURFACE SNAP.

Diamond "H" Switches. Single pole, 5 A. 125 V.; 3 A. 250 V.; Cat. Nos. 220 and 2200. 10 A. 125 V.; 5 A. 250 V.; Cat. Nos. 221 and 2210. Double pole, 5 A. 250 V. Cat. Nos. 122 and 1220. 10 A. 250 V., Cat. Nos. 222 and 2220. 20 A. 250 V., Cat. Nos. 322 and 3220. 30 A. 250 V., Cat. Nos. 422 and 4220. Three-way, 5 A. 125 V.; 3 A. 250 V.; Cat. Nos. 123 and 1230. 10 A. 125 V; 5 A. 250 V.; Cat. Nos. 223 and 2230. Four-way, 3 A. 125 V.; 1 A. 250 V.; Cat. Nos. 124 and 1240. 5 A. 125 V.; 2 A. 250 V.; Cat. Nos. 224 and 2240. Electrolier, 3 A. 125 V.; 2 A. 250 V.; Cat. Nos. 125, 1250, 126, 1260. 5 A. 125V.; 2 A. 250 V.; Cat. Nos. 225, 2250, 226, 2260. Also above types with indicating dials or lock attachments, or both. Approved Feb. 9, 1910. Manufactured by

Hart Manufacturing Co., 103 Allyn St., Hartford, Conn.

WIRES, FLAME PROOF FOR SWITCHBOARDS.

Insulation consisting of an asbestos wind enclosed in two asbestos boards. Tag on coil to read, "Nat'l Elec. Code Standard." Approved, for use where not exposed to moisture as on switchboards, rheostats and similar apparatus subject to high temperatures and where the insulation will be subjected to a difference of potential of not over 600 volts, Feb. 16, 1910. Manufactured by

General Electric Company, Schenectady, N. Y.

NEWS NOTES

INCORPORATIONS.

VANCOUVER, WASH.—The Columbia Power & Light Company has been incorporated for $3,000,000 by Guy W. Talbot.

CALDWELL, IDA.—Articles of incorporation have been filed for the Caldwell Traction Company, for $250,000, by W. R. Sebree.

RICHMOND, ORE.—The Deschutes Mutual Telephone Company has been incorporated by C. R. McLallin, with principal office at Richmond.

CALDWELL, IDA.—Articles of incorporation have been filed for the Caldwell-Roswell-Big Bend Interurban Railway Company for $250,000, by W. P. Howard.

CONNELL, WASH.—The Connell & Kahlotus Telephone Company has been incorporated by Geo. F. Richardson, for $2,000, to build a line from this place to Kahlotus.

THOMPSON FALLS, MONT.—The Thompson Falls Light & Power Company has been incorporated for $30,000 by Edward Donlan, to develop power from Prospect Creek.

NELSON, B. C.—The International Electric Company has filed articles of incorporation for $1,000,000, ostensibly for the electrification of the Crows Nest Pass route of the C. P. R.

WALLA WALLA, WASH.—The Walla Walla Railway Company has been incorporated for $500,000 by Lewis A. McArthur, to build an electric railway from Walla Walla to Milton, Ore.

EVERETT, WASH.—Moses Lake Land Company has been incorporated for operating street railways, etc., also for doing general contracting business, by Daniel Duryea and Schuyler Duryea, for $1,000.

PORTLAND, ORE.—The Tri-State Railway & Power Company has been incorporated by W. D. Riddell, R. B. Mandage and T. M. Peters, with a capital stock of $10,000. The principal office of the company in Portland.

PORTLAND, ORE.—The Rogue River Irrigation & Power Company has been incorporated by P. Williams, A. M. Crawford and W. B. Sherman, with a capital stock of $1,000,000. The principal office of the company is in Portland

TRANSMISSION.

LONG BEACH CAL.—Surveyors have been employed by the Southern California Edison Company, for the purpose of laying out a line for the building of the first unit of the $6,000,000 power plant here.

REDDING, CAL.—The Northern California Power Company has acquired the 209 acres of land near Whitmore it needed to complete its 1,540-acre reservoir site. This is the tract of land for which Daniel F. Covey sued his son and daughter, asking the court to annul a deed of gift he had made to them in 1902. The Court annulled the deed. The power company brought suit to condemn this land. Daniel F. Covey and the company agreed outside of court on terms of sale.

SAN FRANCISCO—Sanderson & Porter report that the Stanislaus transmission line from the station near Angels' Camp to San Francisco, 135.1 miles long, was tested out on on May 7th to 110,000 volts. The regular operating pressure is to be 104,000 volts. At present a very careful inspection of the line is being made for mechanical defects and upon its completion the line will be put into operation transmitting power from the Stanislaus power station to the Bay Shore substation in the Visitacion Valley and thence to the various substations of the United Railroads, which are now being fitted with 1500-kw. synchronous motor generator sets. The main transmission line is Y connected at both the power house and the substation and the distribution to the United Railroads at 12,000 volts delta connected. A motor generator set in one of the United Railroads' substations has been actually operated from the Stanislaus plant. A Bowie high tension switch is being installed near the Bay Shore substation as an emergency protection. The disconnecting switches for outdoor use are being manufactured by the Pacific Electric Manufacturing Co. in San Francisco.

SPOKANE, WASH.—Official confirmation has been received in Spokane of the reported sale of the Northwestern Corporation to the Columbia Power and Light company, recently incorporated under the laws of Idaho, and the Byllesby Company of Chicago, the transaction involving more than $3,000,000. The transfer includes gas plants, franchises and contracts at Walla Walla, Pendleton, Oregon and North Yakima, and electric light systems and franchises at Dallas, Independence, Monmouth, Albany, Corvallis, Eugene and Springfield, Oregon, together with the gas plant at Eugene and water works at Independence, Albany and Springfield. The Byllesby Company, which recently obtained control of the gas and power plants at Olympia, Tacoma and Sandpoint, Idaho, takes over the Coos Bay gas and electric plants and the street railway and the Condor Light and Power Company, held under option by the Northwestern Corporation. The latter company furnishes light and power for Ashland, Medford, Grants Pass, Jacksonville and several smaller towns in Southern Oregon. The Columbia Light and Power Company has also purchased from Robert E. Strahorn of Spokane, president of the North Coast Railway, the Northwest Light and Power system at North Yakima, which serve Mabton, Toppenish, Sunnyside, Prosser, Kennewick and Pasco, and furnishes power for the irrigation districts adjacent to the towns. It is given out that the high tension line will be extended from Pasco into Walla Walla. From Walla Walla comes the announcement that the holdings of the Northwestern Corporation, recently taken over by the American Power and Light Company, will be transferred to the Columbia Co.

ILLUMINATION.

OLYMPIA, WASH.—A. E. Wright of Olympia has been garnted a franchise for a gas plant, the pipes in the business section to be laid within four months.

SAN BERNARDINO, CAL.—A new light plant is to be constructed at the Olinda oil fields of Santa Fe. It will be commenced within a few days and cost $10,000.

OAKLAND, CAL.—The Central Oakland Light and Power company has just built a modern steel frame power station near the water front in Oakland, and the plant will be completed this summer.

GUADALAJARA, MEX.—Geo. H. Eckert of San Francisco and W. A. Aldrich of Grand Rapids, Mich., gas engineers, have arrived here to take charge of the work of installing a gas plant and distributing system for the Gas Operating and Construction Company of Los Angeles organized to operate under a concession secured from the state government by J. Guillermo Dominguez. W. S. Morse, head of Morse Lumber Company of Los Angeles, is the president of the company.

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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FOR INDEX TO ADVERTISEMENTS SEE PAGE EIGHT

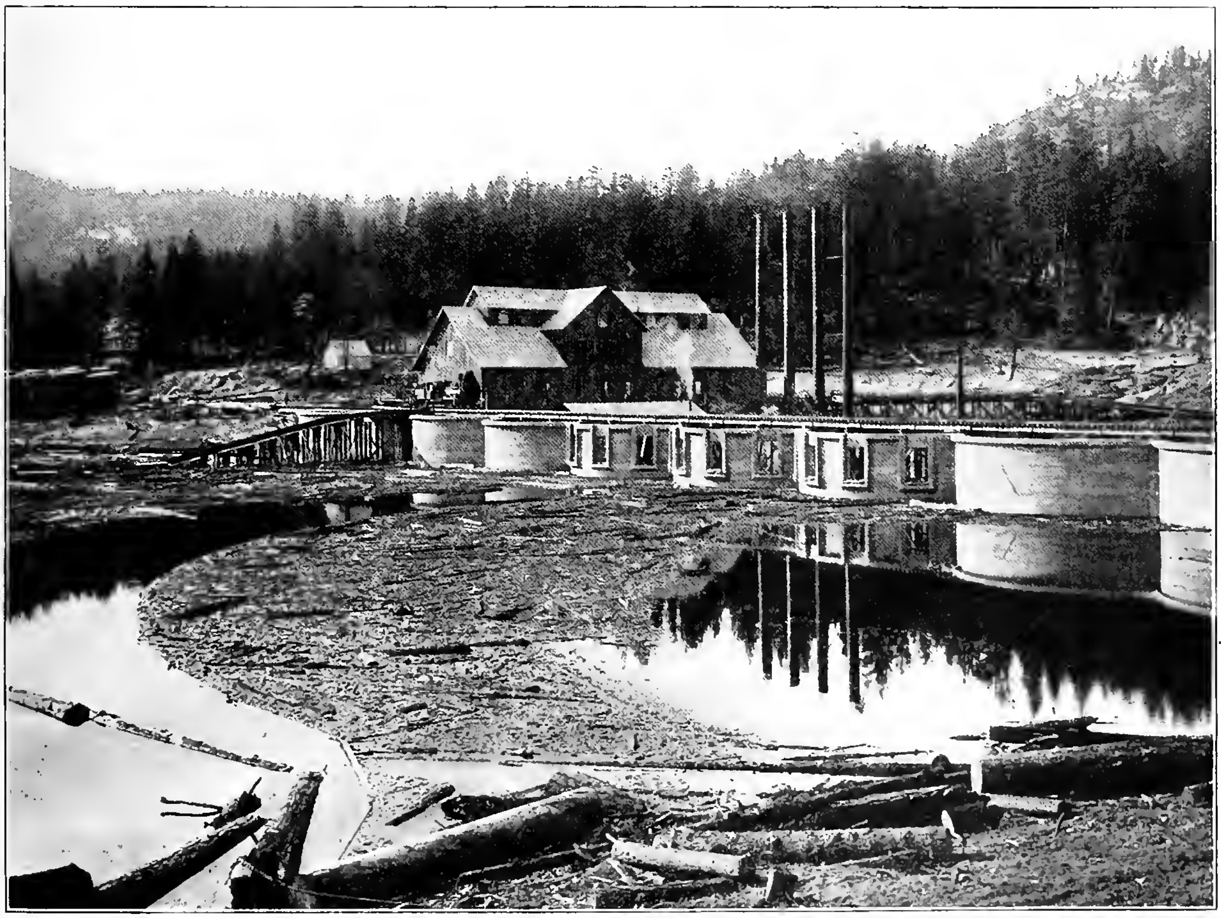
JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXIV — SAN FRANCISCO, MAY 21, 1910. — NUMBER 21

ARCHED DAMS

BY L. R. JORGENSEN.

The usual practice in curved dam construction is to span the canyon with one continuous arch. For spans less than 600 ft. a curved dam of this type requires less material for the same factor of safety than a straight gravity dam (Wegmann section). If the gap to be closed is over 600 ft. wide, the cross sectional area of the arch becomes nearly as great as the cross sectional area of a gravity dam for equal stresses, and when it is considered that the arch is always longer than the chord, it is evident that the limit of economy for a single arch span has been reached, if special conditions are not present. Recently the multiple arch type of dam has come into existence and given promise of allowing big reductions in the quantity of material required for structures safely spanning gaps of any width.



Completed Multiple Arch Dam at Hume, California.

The Hume Lake dam near Fresno, California ("Journal of Electricity, Power and Gas," October 30, 1909, December 25, 1909, February 12, 1910), designed and constructed by Mr. J. S. Eastwood, is the first

example of this kind of structure in the United States, and Mr. Eastwood is to be congratulated upon successfully carrying out this work "without precedent."

In the following, comparisons are made between different types of arched dams for the same sites. All dams are calculated for 125 ft. height. Fig. 1 shows a section to be used for a 200-ft. span. The thrust is taken up partly by arch action and partly by gravity section and the content of the dam must also vary proportionately to variations in the length of the radius. The content of any curved dam = 2 x mean radius x enclosed angle x area of cross section; and will for practical profiles be found to be a minimum, when the enclosed angle is about 120 degrees. The exact value will depend upon the shape of the canyon and the top thickness adopted.

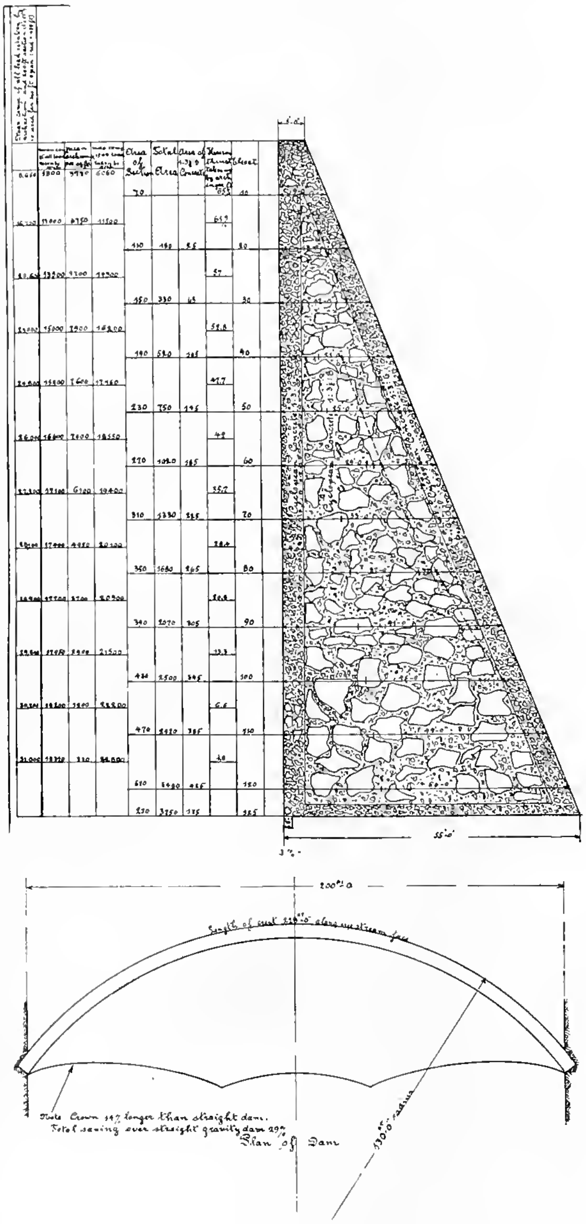


Fig. 1.

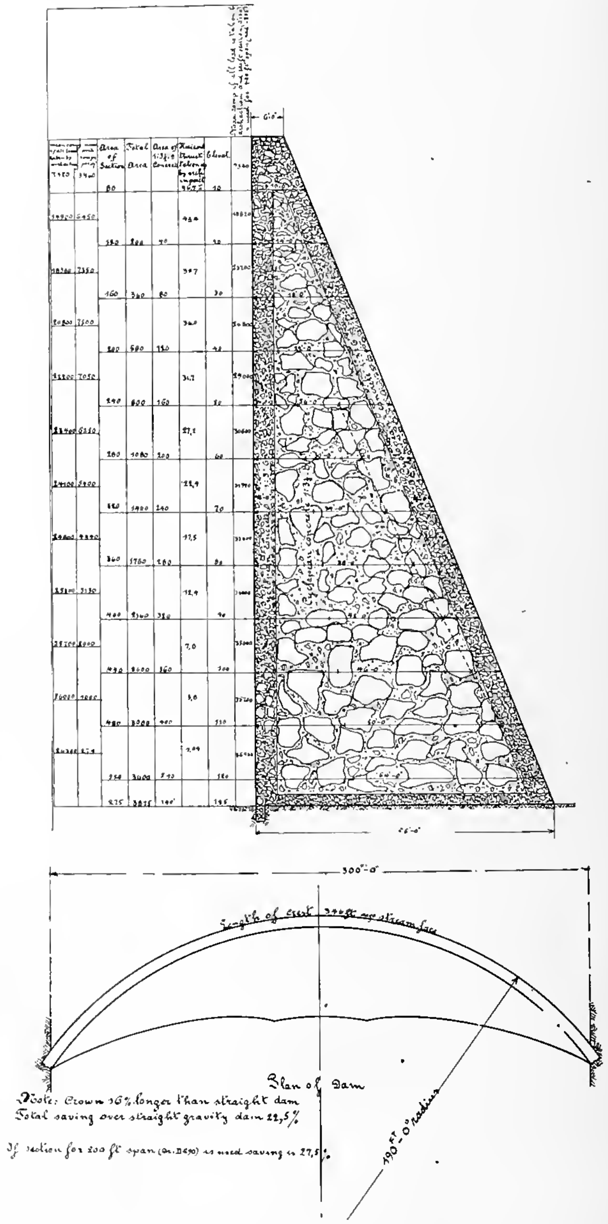


Fig. 2.

action, and it was decided to design the section in such a way that the line of pressure, reservoir full, due to the portion of load taken up by gravity action, should cut the base inside the section. This condition gives the profile a factor of safety against overturning of at least 1 due to gravity alone. Before the proportions of thrust taken respectively by gravity and arch action can be found, the radius of curvature must be decided upon. As the thickness of the masonry varies directly with the radius of curvature, the area of the cross

For the section shown in Fig. 1 a smaller angle and a correspondingly larger radius (130 ft.) was used in order to load the material which had to be there in order to satisfy the first condition of keeping the line of pressure, reservoir full, within the section.

The percentages of the horizontal thrust of the water taken up by arch action at different elevations were computed from formulas given in discussions on the paper "Lake Cheeseman Dam and Reservoir," especially from one developed by Mr. R. Shirreff

(Trans. A. S. C. E., Volume LIII). They are too lengthy to be given here. The remainder of the thrust is taken up by gravity action. From tables accompanying Fig. 1 this portion is seen to be the smallest at the top and increasing towards the foundation, or, on the other hand, the thinner the arch ring is, the more thrust is taken up by arch action. A calculation was also made to find the unit stresses assuming all the load carried by the arch action, as this is the most

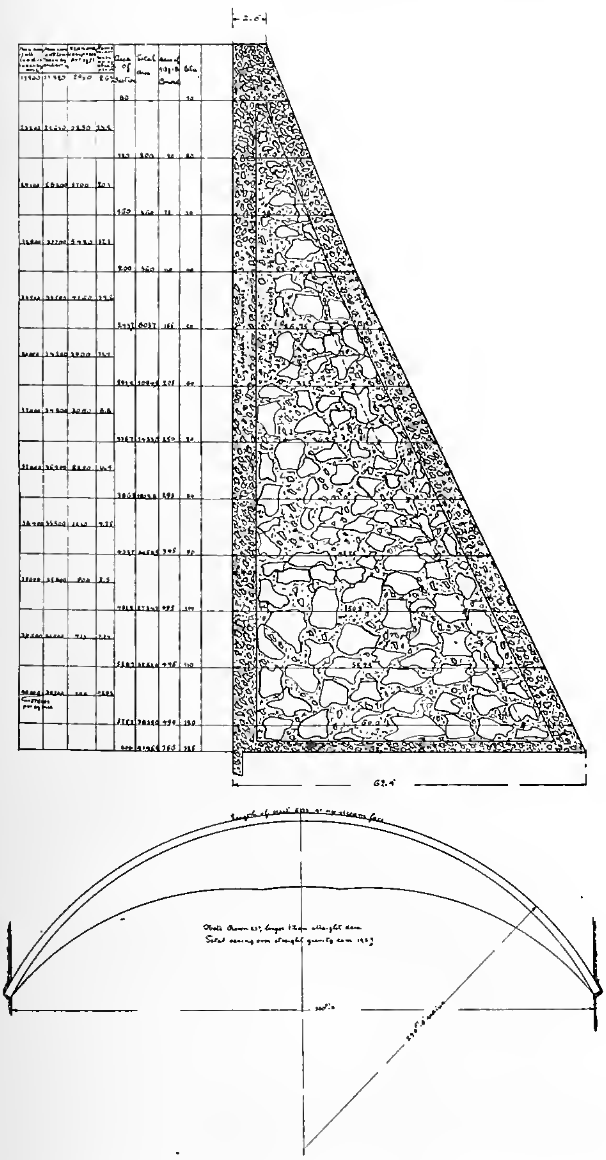


Fig. 3.

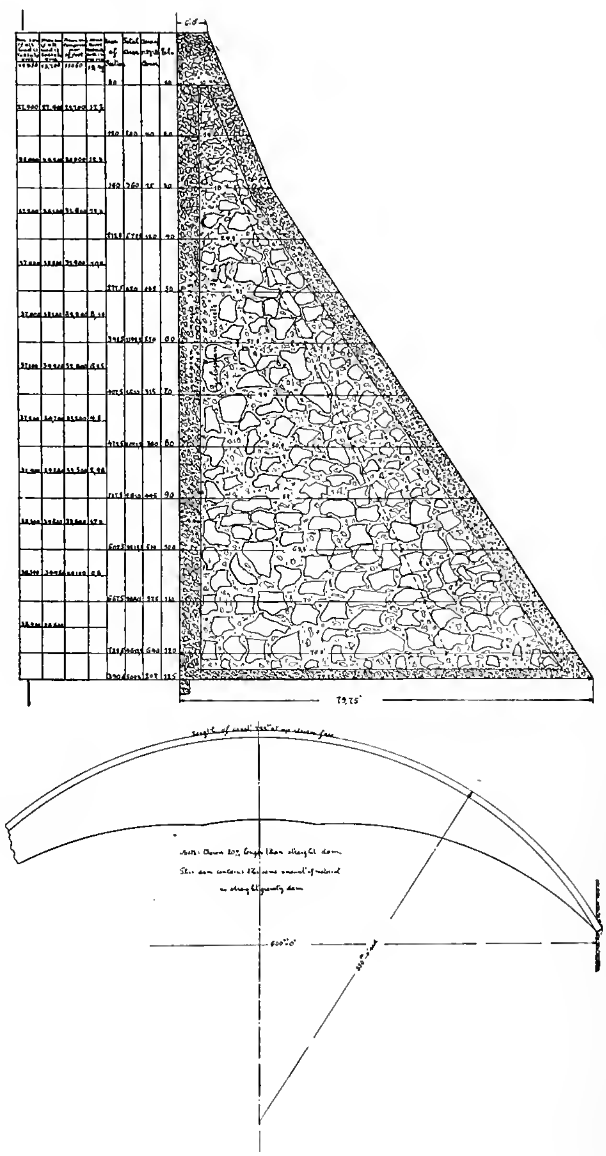


Fig. 4.

severe condition possible. The results are given in tables accompanying Fig. 1, where mean stresses and maximum stresses (compression in lbs. per sq. ft.) are found for elevations spaced at intervals of 10 ft. The mean stresses were found from the usual equation:

$$P \times R = X \times L,$$

where P is the water pressure per sq. ft. at the joint considered, R = up-stream radius, L = length of joint, and X = mean compression per sq. ft. of material. Assuming that the intensity of the stress varies uniformly from the up-stream face to the down-stream face of the arch, the maximum unit compression is found from

$$\frac{\text{maximum compression}}{\text{mean compression}} = \frac{2\,R}{R + r}$$

where r = radius of down-stream face of dam at joint under consideration.

Take, for example, an arch ring at elevation 115 ft. 1 ft. high. P = 62.5 x 115 (62.5 = weight of 1 cu. ft. of water); R = 130; L = 51. The mean compression

$$= \frac{62.5 \times 115 \times 130}{51} = 18{,}320 \text{ lbs, per sq. ft.}$$

and the maximum compression

$$\frac{2 \times 130}{130 + (130 - 51)}\, 18{,}320 = 22{,}800 \text{ lbs. per sq. ft.}$$

This unit compression is probably the highest that could be developed anywhere in the section. Going to lower elevations will bring us so close to the foundation that the arch action cannot be developed and some of the load is taken up by shear action.

The above maximum unit compression is very low, but cannot be increased if the section shall be big enough to allow the line of pressure, reservoir full, to fall within the section.

Fig. 2 shows a section designed to be used for a span of 300 ft. Fig. 3 shows a section intended for spans from 400 to 500 ft., and Fig. 4 shows a section intended for a 600-ft. span. Above this limit arch dams of this type are not economical. All profiles are calculated in the same manner as the one shown in Fig. 1. The limiting conditions being that the line of pressure, reservoir full, should fall inside the section, and that the maximum unit compression in no case should exceed 40,000 lbs. per sq. ft., considering the arch to take all the thrust. It is believed that the resulting sections are conservative, have a higher factor of safety than a straight gravity dam, and contain less material (percentages given on Figs. 1, 2, 3 and 4 in each case) than this, except in the section shown in Fig. 4.

Multiple Arch Dams.

Fig. 5 shows a section and plan view of a multiple arch dam, designed for a height of 125 ft. and a distance of 50 ft. center to center of buttresses. After some preliminary calculation, the radius of the extrados is chosen 32 ft. and the slope of the up-stream face 55 degrees, except the upper 10 ft. The top thickness is taken at 18 in. and is carried down to 10 ft. depth, from here to the bottom of the reservoir the thickness is increased uniformly just enough to insure watertightness. At 120 ft. depth the thickness of the arch is 7 ft. The mean unit compression at this depth, therefore, becomes (using the same formula as before):

$$X = \frac{62.5 \times 120 \times 32}{7} = 34,300 \text{ lbs. per sq. ft.}$$

where R = 32; L = 7; P = 62.5 x 120.

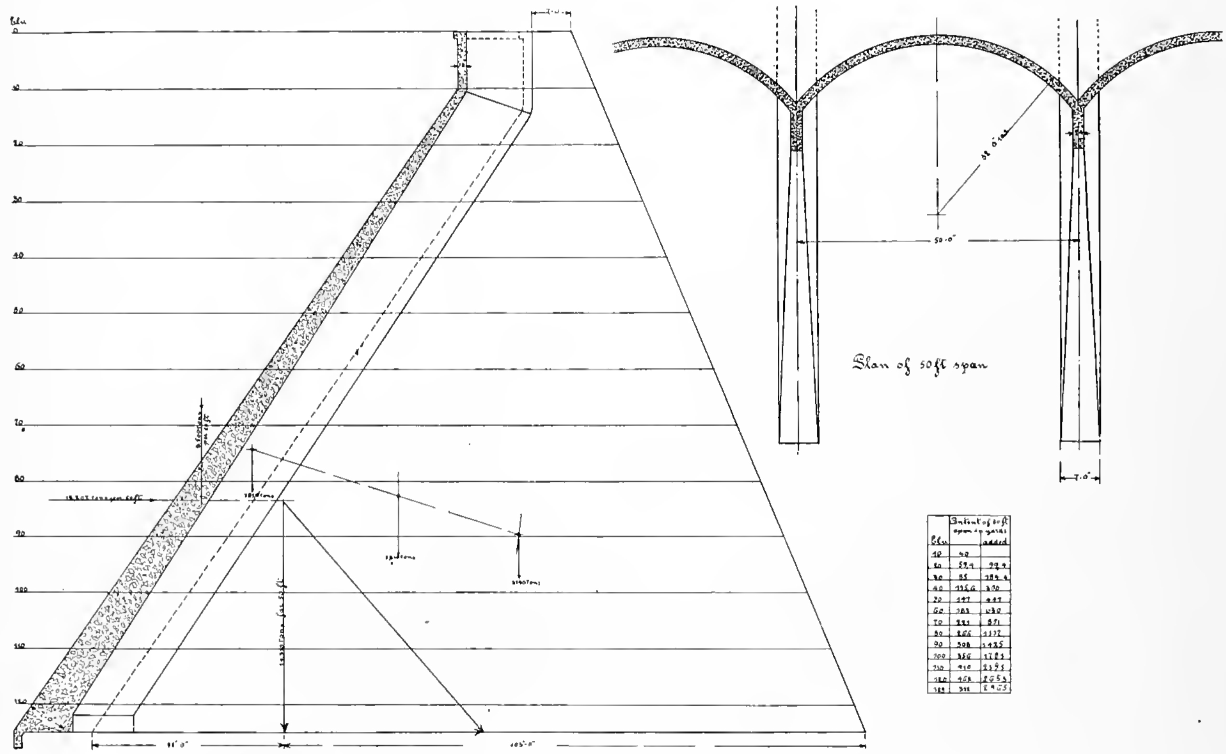


Fig. 5.

The maximum unit compression will be larger and in proportion to

$$\frac{2\text{ R}}{\text{R} + (\text{R}-\text{L})} = \frac{64}{57}$$

hence, maximum compression $= \frac{64}{57} \times 34,300 = 35,000$ lbs. per sq. ft.

The dimensions of the buttresses are also adopted after some preliminary calculation to be 2 ft. x 7 ft. at the top and 7 ft. x 132 ft. at the foundation.

All information necessary to determine the points of application of the different forces is now at hand.

Content of buttress = Area x average thickness = 8250 x 1/3 (2 x 7 + 2) = 44,000 cu. ft. = 1630 yds. = 3190 tons.

Content of arch = area of cross section x average length of arch $= 4.5 \times 150 \times \pi \times 59.5 \times \frac{103}{360} = 36,050$ cu. ft. = 1335 yards = 2,620 tons.

Total content 2965 equal approximately 3000 yds. for a 50-ft. section.

The center of gravity of the pier lies on its center line, a distance of

$$\frac{125}{2} \times \frac{7 + 2}{2 \times 7 + 2}$$

= 35.1 ft. above the foundation.

The center of gravity of the arch cross section is found; then the center of gravity of the whole arch will lie on the radius to the point approximately one-third the height of the arc inside the center of gravity of the arch cross section.

The horizontal distance between the center of gravity of pier and arch is 47.5 ft. and the combined

center of gravity will, therefore, be a distance y from the center of gravity of pier found from

$$2620 \times 47.5 = y\ (2620 + 3190)$$

$$y = \frac{2620 \times 47.5}{2620 + 3190} = 21.4 \text{ ft.}$$

The vertical component of the water pressure acting on the sloping up-stream face will act as weight and the point of application (or at least the plane of application) of the combined weight of the dam and the vertical component of the water pressure must be found:

The vertical component of the water pressure amounts to $115 \times \text{tg}\ 35\ \frac{7812 + 625}{2} = 340{,}000$ lbs. = 170 tons per running ft., or 50 x 170 = 8500 tons per 50 ft. section.

The horizontal distance between point of application of vertical component water pressure and center of gravity of dam = 35 ft., then distance y_2 between center of gravity of dam and center of total vertical forces found from $8500 \times 35 = y_2\ (8500 + 5810)$: $y_2 = \frac{8500 \times 35}{8500 + 5810} = 20.8$ ft.

The resultant of the total vertical forces cuts the base 35 ft. from the up-stream end of the buttress and, as the total length of the base, including thickness of arch, is 138 ft., it is seen (measured on drawing) that the point of intersection is $\frac{138}{3} - 35 = 11$ ft. outside the middle third.

The compression per sq. ft. at the up-stream edge of the pier follows from

$$g = \frac{2\,W}{L}\left(1 + \frac{\frac{L}{3} - u}{\left(\frac{L}{3}\right)}\right)$$

where L = 138 ft., u = 35 ft., W = 8,500 + 5,810 =14,300 tons, $g = \frac{2 \times 14{,}300}{138}\left(1 + \frac{11}{46}\right) = 257$ tons per 50 ft., or 5.14 tons per running ft.

The compression per sq. ft. at the down-stream edge of the pier follows from

$$\eta = \frac{2\,W}{L} - g = 207 - 257 = -50 \text{ tons per 50 ft.,}$$

or — 1 ton per running ft.

This negative compression or tension never takes place, as is easily seen, when the action of the horizontal component of the water pressure is also taken into consideration, but this negative compression helps to compensate for the positive compression due to the action of the horizontal component, making it possible to keep the buttress nearly uniformly loaded from heel to toe.

This is a distinct feature of the sloping face and the large saving in material possible with this type of dam is to a great extent due to the fact that the buttress is nearly uniformly loaded from heel to toe with reservoir full.

The value of the horizontal component of the water pressure per running ft. is found from

$$62.5 \times \frac{125^2}{2} = 488{,}280 \text{ lbs.} = 244.14 \text{ tons.}$$

The point of application of this force is $\frac{125}{3} =$ 41.66 ft. above the foundation and its moment around any point in the foundation at elevation 125 is for a 50-ft. span

$$41.66 \times 244.14 \times 50 = 509{,}000 \text{ lbs.}$$

$$\text{Moment of inertia of base} = \frac{b \times L^2}{6} = \frac{50 \times 138^2}{6} = 158{,}700.$$

The stress in the material at the toe and heel due to the turning moment of the horizontal component of the water pressure will then follow from

$$\frac{\text{Bending moment}}{\text{Moment of inertia}} = \frac{509{,}000}{158{,}700} = 3.21 \text{ tons.}$$

The resultant compression of the toe due to weight of structure and to vertical and horizontal component of water pressure is then: 3.21 — 1 = 2.21 tons per running ft. As the buttress is 7 ft. wide at the base, the compression per sq. ft. become $2.21\ \frac{50}{7} = 15.8$ tons.

The resultant compression at the heel per sq. ft. of buttress $= (5.14 - 3.21)\ \frac{50}{7} = 13.8$ tons.

The difference between the unit compression in the toe and in the heel is seen to be not very great at the base and is decreasing towards higher elevation until the two stresses become equal, at which elevation the load is uniformly distributed between toe and heel. From here on towards the top of the dam the compression at the heel becomes larger than at the toe.

By varying the slope of the up-stream face, the elevation where the load is uniformly distributed can be shifted up or down as desired. The unit compression along the down-stream edge of the buttress should diminish from the foundation towards the top, as this edge is the least supported portion of the structure, and it adds more to the stability to increase the up-stream slope, thereby throwing the load towards the up-stream edge of the buttresses, than it does to increase the thickness of the buttress, the unit load on these being already low.

Shearing Stresses.

The horizontal component of the water pressure, besides tending to overturn the dam, also has a tendency to shear it off the foundation. Before actual shearing stresses can be fully developed, the friction between the dam body and the foundation must be overcome. This friction is equal to the sum of all the vertical forces x the coefficient of friction = 14,310 x 0.75 = 10,750 tons.

As the horizontal water pressure is 12,207 tons, the amount of pressure tending to shear the structure off the foundation is 12,207 — 10,750 = 1457 tons per 50 ft., giving 1.1 tons per sq. ft., or 15.3 lbs. per sq. in. a negligible amount, showing that practically this structure is only called upon to withstand compression and, therefore, steel reinforcing is unnecessary.

Comparison of Material in the Different Structures.

A 50-ft. section of multiple arch dam contains 3000 yards. A 50-ft. section of straight gravity dam contains 9680 yards. Proportion

$$\text{Proportion} \frac{\text{Multiple arch dam}}{\text{Gravity dam}} = \frac{3000}{9680} \times 100$$

= 31 per cent. of gravity dam.

The amount of material required for a straight gravity dam is seen to be 3.22 times that of a multiple arch dam. Even assuming the unit cost of material for a multiple arch dam to be twice that of a straight gravity dam, it is still possible to construct the multiple arch dam 1.61 times cheaper.

The dam shown in Fig. 1 requires 29 per cent less material than a straight gravity dam across the same canyon. A multiple arch dam would be 25 per cent cheaper to construct, even with unit prices taken twice as high as for the cyclopean concrete used for the single arch. The factor of safety of the single arch section shown in Fig. 1 would, however, undoubtedly be greater than for both a gravity section and a multiple arch section. The unit loads are less and it also has some safety against overturning acting as a gravity dam.

The dam shown in Fig. 2 contains 22.5 per cent less material than a straight gravity dam across the same canyon. The factor of safety of this section would probably also be somewhat higher than both a gravity section and the multiple arch section; the latter, however, would be 31 per cent cheaper to construct, using the same proportion between costs as before.

In the same way the dam shown in Fig. 3 will cost 41 per cent more to construct than a multiple arch dam and the dam also shown on Fig. 4 will cost the same as a straight gravity dam, or 61 per cent more than a multiple arch dam.

From the above it seems evident that the multiple arch dam always has the advantage of requiring less material than any other masonry dam, and, therefore, this type of structure will undoubtedly come into extensive use in the future, at least for moderate heights. For great heights the buttresses must be stiffened or the unit load kept very low to prevent buckling, and this of course adds to the amount of material absolutely necessary.

Examination Surveyor, Philippine Service. The United States Civil Service Commission announces an examination on June 15, 1910, to fill at least fifty vacancies in the position of surveyor, at $1,400 per annum each, in the Philippine service. Field expenses are allowed appointees when absent on duty from their permanent station. Eligibility for the position will be determined upon the evidence furnished in application concerning their education, training, and experience. Applicants qualified as follows will be acceptable as surveyors: (a) Senior year students in civil engineering who are attending recognized technical schools or colleges, and whose records are satisfactory; (b) persons who have had not less than three years' good experience in general land and topographic surveying and in addition thereto a good general education.

DISCHARGE FROM TANGENTIAL IMPULSE WATER WHEELS.

BY S. L. BERRY.

The determination of the discharge capacity of tangential impulse water wheels is intimately connected with the question of the maximum stream which should be applied to a wheel of certain dimensions. In the case of many of the larger units the speed of the wheel is determined by the requirements of the machine to which it is directly connected, and, as the head is also usually fixed in any particular case, the diameter of the wheel is predetermined by conditions over which the manufacturer has little or no control. It then becomes his duty to provide the power called for whether the conditions are as favorable as he would like or not.

There are too many conditions attending the passage of the buckets through the stream which have not yet been worked out to make it possible to provide exact formulae, and the following are given as approximations to assist in design.

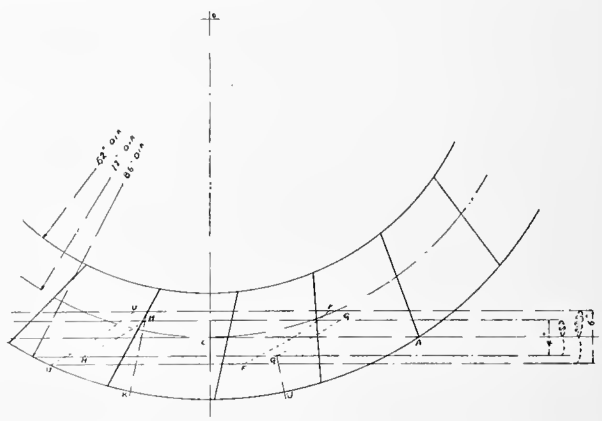


Fig. 1.

Fig. 1 is a diagram of a wheel of the following dimensions:

Pitch diameter	72 in.
Outside diameter	86 in.
Diameter at inner end of buckets	62 in.
Diameter of small jet	4 in.
Diameter of large jet	6 in.
Number of buckets	22 in.
Velocity of pitch line relative to spouting velocity	0.46

An article published in the "Journal of Electricity, Power and Gas," December 25, 1909, explained a method of determining stream paths and points of discharge of the water. Applying that method to Fig. 1, the line GG locates the commencement of discharge for the 4-in. stream from a bucket of proper width, and HH the final; while FF and UU show similar points for the 6-in. stream from its wider bucket.

It will be seen that while the wheel travels from J to K the bucket is discharging the full 4-in. stream, and similar lines drawn through the lower F and upper U will show a shorter arc, located further along in the direction of motion, for the full 6-in. stream discharge.

The length (S) of the slug of water taken care of by each bucket depends upon the pitch (B) of the buckets measured on the pitch circle, and the pitch line

velocity (ϕ) relative to the spouting velocity, and is given by the formula:

$$S = \frac{B}{\phi}$$

This will be the same in all parts of the stream, although the ends of the slugs will not be square.

As the operation of receiving and discharging is continuous, with no piling up of the water in the buckets, the time of discharge will be equal to the time of receipt, and the question becomes one of velocities and areas. The area of the jet and its velocity are given and it remains to determine those quantities in connection with the discharge.

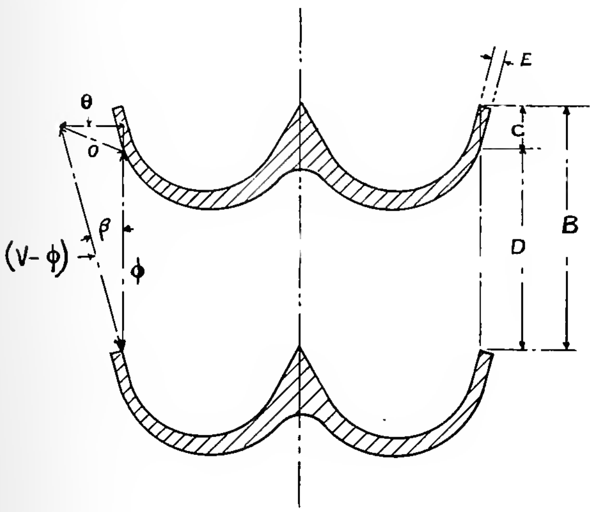


Fig. 2.

Fig. 2 is a section through two buckets on the pitch line, and shows the diagram used to determine discharge velocities. Let

A = Area of jet in square inches.
B = Pitch line spacing of buckets.
C = Space occupied by bucket metal.
D = Space between buckets available for discharge.
E = Thickness of buckets at discharge.
L = Radial length of discharge.
V = Spouting velocity of water.
v = Axial component of discharge velocity.
β = Angle of discharge.
ϕ = Ratio of pitch line velocity to spouting velocity.
o = Ratio of discharge velocity to spouting velocity.
θ = Ratio of axial component of discharge to spouting velocity.

Then

$$C = \frac{E}{\sin. \beta}$$

$$D = B - C$$

$$\theta = (V - \phi) \sin. \beta.$$

The product of the area of the jet by its velocity equals the product of the area of discharge by the axial component of its velocity. As there are two discharges the formula is

$$AV = 2 \text{ v } DL$$

and

$$L = \frac{A\ V}{2 \text{ v } D}, \text{ substituting the ratios,}$$

$$L = \frac{A}{2\ \theta\ D}$$

In the example shown,
B = 10.28 in.
E = 0.5 "
ϕ = 0.46
β = 15°.

Then
D = 8.35
θ = 0.14.

Applying the formula to various streams the following values of L result:

Dia. of stream	4"	4½"	5"	5½"	6"	6½"
β = 15°, L =	5.37	6.80	8.40	10.15	12.10	14.17

With the discharge angle β = 10°, the results are very largely increased:

Dia. of stream	4"	4½"	5"	5½"	6"	6½"
β = 10°, L =	9.06	11.5	14.18	17.11	20.4	23.9

It will be seen from the formulae and table that with the relative velocity of the wheel, pitch of buckets, thickness of edge and angle of discharge fixed, the radial length of bucket edge required for discharge varies as the area of the jet or as the square of the diameter, that a wider angle of discharge permits a less length of edge, and that a greater relative bucket velocity requires a greater.

The table shows that with a discharge angle of 15 degrees the discharge of a 6-in. stream occupies about 12 in. (the distance between the inner and outer bucket circles) during the time of full discharge, provided, however, that the design is such that the space (D) between the buckets is completely full. This is an extremely difficult condition to control, and there is considerable danger of overcrowding in this direction. The fact that the discharge edges are curved at their inner and outer ends would add to their actual lengths.

With a discharge angle of 10 degrees, a value of L = 12 in. is reached with a stream of 4.6 in. diameter.

Examination Wireless Telegraph Operator. The United States Civil Service Commission announces an examination on June 1, 1910, to fill a vacancy in the position of electrician and wireless telegraph operator (male), $75 a month, Light-House Service, for duty under the Assistant Inspector of the Twelfth Light-House District, Territory of Hawaii.

FEDERAL CONTROL OF WATER POWER.[1]

BY RUSSELL L. DUNN.

Stripped clear of the acrimonious, motive-impugning discussion, which, expending itself in personalities, has suppressed and concealed the real difference at issue between President Taft, Secretary Ballinger and their supporters, on one side, and a very large number of people led and misled by the late chief officer of the Forestry Department, Mr. Pinchot, on the other side, is that the former maintain that a "permittee" (tenant) on the public land is entitled by law to have the covenants or conditions of his "permit" (tenancy) predetermined precisely and fixed in an Act of Congress, while the latter maintain that the administrative officers should not be interfered with by Congress, because they already put the same covenants and conditions up to "permittees" (tenants) without the aid of Congress in the matter.

It is a difference paralleled by the difference between a court, which has found the accused guilty as charged, but wants to give him benefit of clergy before the Sheriff hangs him, and a howling mob without the court, which, too, having found the accused guilty as charged, would have the Sheriff do the hanging forthwith without any benefit of Congress.

As for the "accused found guilty as charged," who is not apparently consulted over the mode of precedence to his near end by either court or mob, who or what is he?

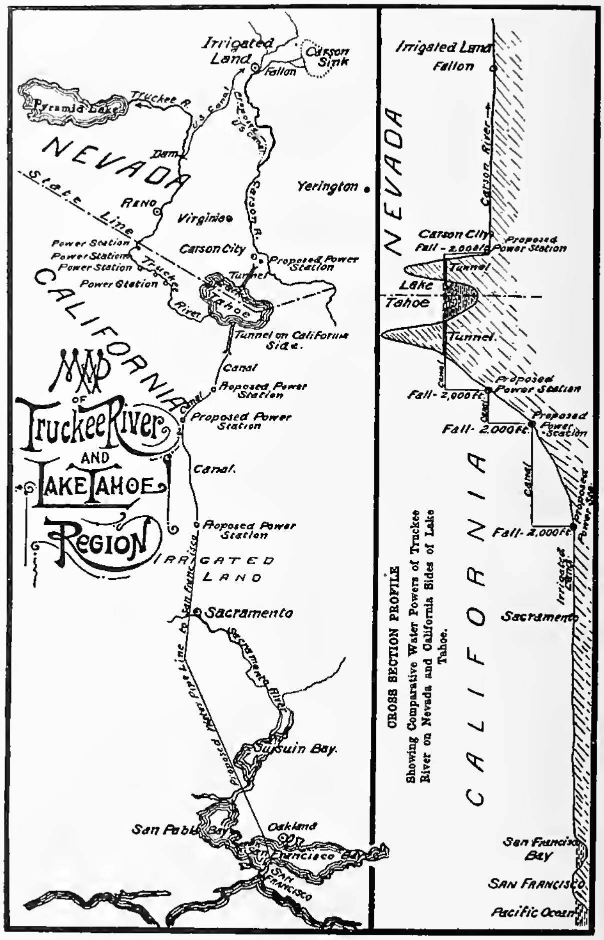
Not the appropriator of water for public purposes or uses, not the great soulless public service corporations, not the portentious predatory "water power trust"—not these undesirable citizens, or any of them, that court and mob alike have been fooled into thinking in their Sheriff's custody primed for the hanging. They are clear out of it, because the right to appropriate and use the flow of the water of the streams is sovereign property of the State, and the State procures for its sovereign property, by virtue of its eminent domain, the easements for rights of way on the public land for emplacement of waterworks.

But the appropriator of water for private purposes and uses is "the accused found guilty as charged"—the gold miner, the lumberman, the cattleman, the farmer—not the "big fellow" but the "little fellow"—the "ultimate consumer." This is he who President Taft and Secretary Ballinger and Mr. Pinchot and Congress and the people will catch with the great chain net of public opinion and the law which they have been dragging at cross purposes for the honor of landing the catch—this is he, "the ultimate consumer." Was there not a reward offered for the discovery of the "ultimate consumer"? There should be a reward for saving him from being caught now that he is discovered.

An Exhibit of Federal Control of Water Appropriation

It has been recently suggested by a United States Senator in a published interview, that although California undoubtedly owned the right to use the water of the streams, it was necessary in the best interest of California for the Federal Government to control the use, as it would require a great many years of Federal education before California would know how to control its own property properly. Perhaps the Senator knows—but, how does he happen to know? Surely not by the control exhibits already made by Secretaries of the Interior and chief officers of departments.

The control undertaken by them over the use of the water of Lake Tahoe and the Truckee River, an interstate lake and river, as both are part in California and part in Nevada, is an exhibit which has been discussed in the newspapers and magazines without informing anyone what it really was. The map here-



with, and the sketch cross section profile with it, are intended to illustrate the explanation of this exhibit of Federal control of the use of water.

The Truckee River naturally dicharges Lake Tahoe in California and after 60 miles of flow in California enters Nevada, discharging itself a hundred miles inside of Nevada into Pyramid Lake. The United States has no riparian proprietorship whatever along the Truckee River in California, there being no public land touching the river, and has only a minor fraction of the riparian frontage from public land in Nevada. The Federal Government officials thus appear as basing their right of invasion of the two States on a claim of direct control of the water flow by virtue of ownership of it, and not through ownership of land, by the United States.

[1]Extract from "The Control of Use of Stream Water in the United States," published in pamphlet form by the author.

Between Lake Tahoe and the California boundary the Truckee River water falls very uniformly through its course a total of 2,000 feet. Part of this fall, altogether about 700 feet, is used by means of five electric power generating stations, the power produced being consumed in public service, a little locally, and the larger part in Nevada at Reno, Virginia City, Carson City and Yerington. None of the river water is consumed in California, all of it flowing by the river into Nevada after passing the water wheels.

The United States Reclamation Department has diverted part of the Truckee River water in Nevada and conducting it by a canal has distributed it for irrigation over lands in the sink region (ancient dried up lake bed) of Carson River, for which the Carson River did not by itself provide a sufficient irrigation water supply.

About eighteen months ago the United States Reclamation Department and the public service corporation operating the power stations seem to have simultaneously discovered, the former that it wanted more water from the Truckee River for its irrigation service, and the latter that it wanted more power from the fall of the water of Truckee River together with a cheaper and more certain opportunity to get it than by building more power stations along the Truckee River.

Thereupon, a contract was entered into between the United States by the Secretary of the Interior and several chiefs of departments (assuming authority under the Act of Feb. 15, 1901), and the public service corporation. The contract is like a diplomatic treaty between high contracting parties in that one can read it without finding out from it what any party expects to get—really get—under its covenants.

Disregarding the formal words and loosely expressed covenants, and going instead to the heart of the matter, this is what the public service corporation expects to get under it:

(1) The right to tunnel through the mountain rim on the Nevada side of Lake Tahoe, by means of which it will be able to use all of the water which would flow from the lake in a single fall of 2,000 feet, thereby trebling the quantity of its electric horsepower output and having all the economy of operation of a single power station as against seven or eight along Truckee River.

(2) The power of the Federal Government to close the natural outlet of Lake Tahoe into the Truckee River so that the water will have to be discharged through the power company tunnel.

And this is what the United States Reclamation Department would get:

(1) The water of Lake Tahoe discharged from the power station into Carson River instead of into Truckee River—the same water but not any more water—which the United States Reclamation Department would then conduct to the same land which it is now irrigating by means of a new canal from the Carson River instead of the already constructed canal from Truckee River.

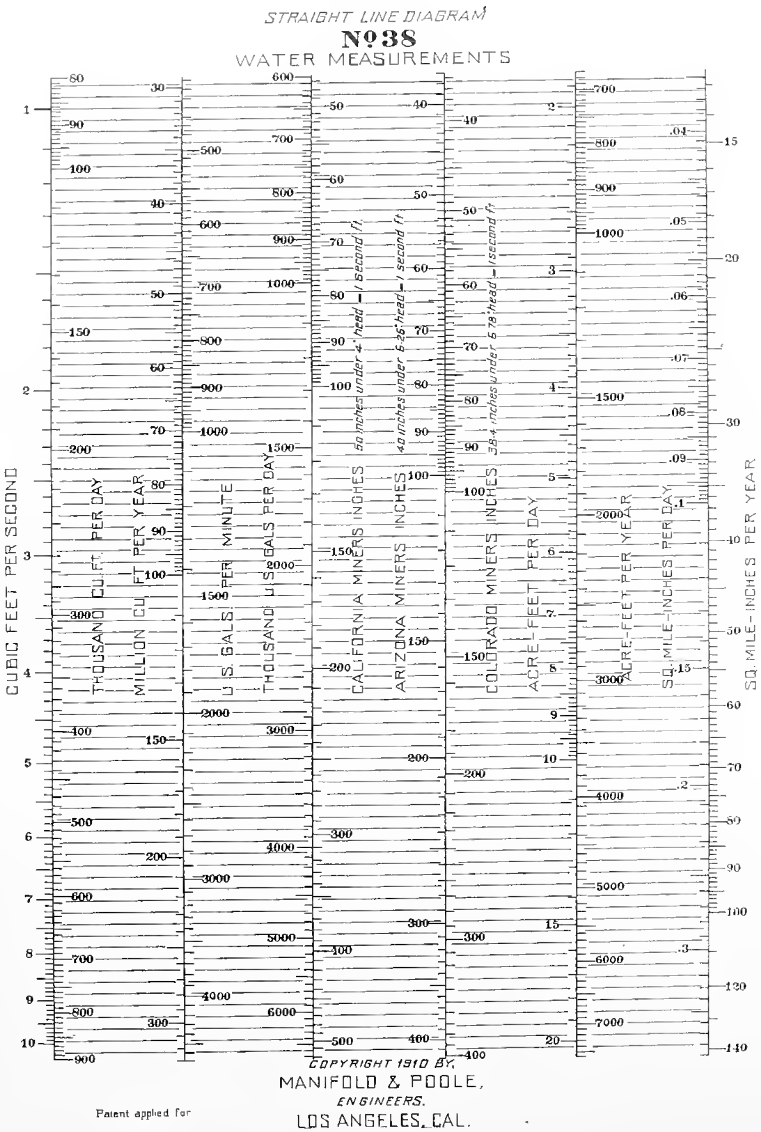
The preceding is the practical business of the contract. Consider the contract now as an instrument of Conservation by Federal control of the use of the water flow of Truckee River, keeping in mind that the chief officers of Federal departments disregarding the State boundaries in providing for the diversion of the flow of Truckee River through California into Nevada, must assume that they could just as well have provided for the diversion the other way, from Nevada into California, a plan of diversion, by the way, which was proposed by engineers forty years ago to supply San Francisco with water.

Referring to the map and cross-section profile sketch, it will be noted that diverting Truckee River water from Lake Tahoe by means of a tunnel through the mountain rim on the California side, the same water could be used through three falls, each of 2,000 feet, to produce electric power, and the water would then be in a region in California in which the land has a productiveness under irrigation double that of the land in the Carson sink in Nevada—or the water could be used for the domestic supply of San Francisco in place of irrigation.

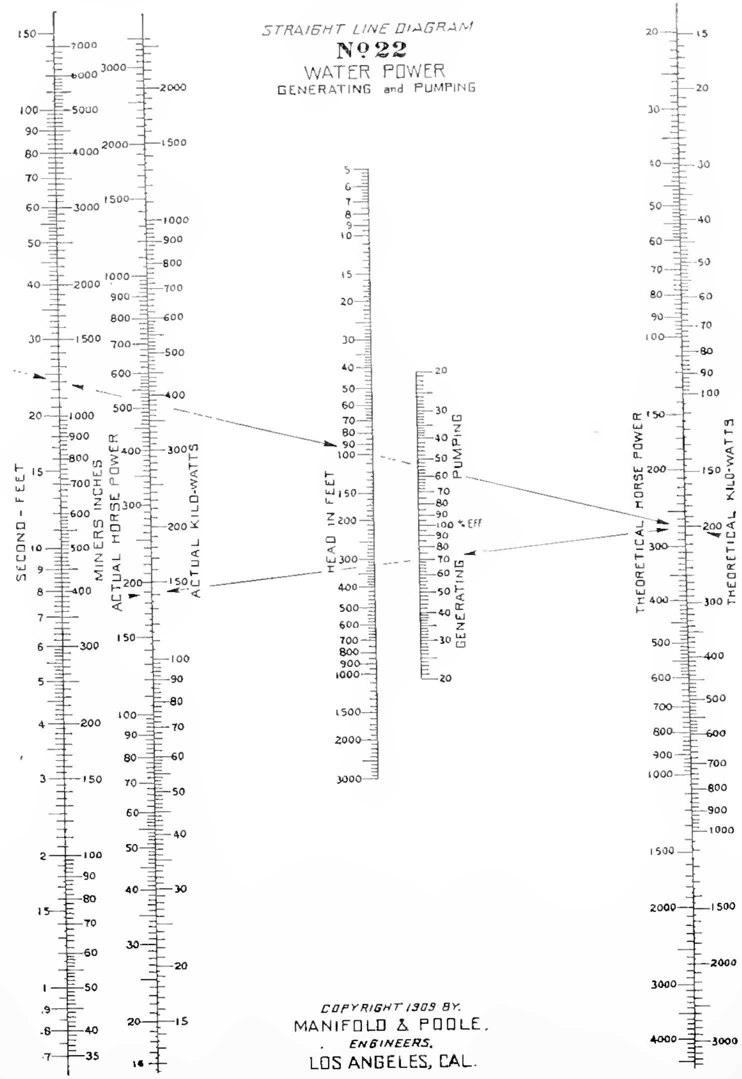
If "conservation" of the use of water means anything but a meaningless political "war-cry," it means getting all of the use out of the flow of the water that it can be made to give. Obviously in this particular exhibit the Federal control has only provided for getting one-third of the possible electric power and not much more than half the possible irrigation service. Apprentice work may be the reason for such a result but the "baby act" plea will not excuse it. Would the State control of the use of the water flow of Truckee River show such a poor "conservation" result? Hardly—but California has never assumed that it could lawfully divert the water of Truckee River from Nevada, nor has Nevada ever assumed that it could lawfully divert the water of Truckee from its natural flow through California directly into Nevada by a tunnel in the Nevada jurisdiction. The Supreme Court of the United States has invariably ruled against such doctrine. It is also quite beyond the legal power of a public service corporation, or the legal power of any citizen, by a contract with anybody, to take outside of its jurisdiction, the sovereign property of California in the use of the flow of the Truckee River within its own jurisdiction. The contract after all is only an exhibit of a carelessness of official action by chief officers of Federal departments which amounts to indifference to the current law of the rights of property. It has not affected the property rights which it was intended to dispose of any more than if the paper it is engrossed on had been left blank as it came from the paper mill.

In review of the foregoing, it would seem, that with the right to appropriate and use the water in the streams which flow on, by, or adjacent to public land, the sovereign property of California, and with the jurisdiction of the State's eminent domain over the public lands with which to procure easements of rights of way for water works emplacement for public purposes and uses, that the imposition, through erroneous assumptions, of the burdens of a Federal jurisdiction over either water use or rights of way easements for water works on the public lands in California should be impossible. But, as Brer Jasper preaches, "De sun do move." Anything is possible in California.

STRAIGHT LINE DIAGRAMS FOR CONVERSION OF WATER POWER UNITS AND DETERMINATION OF WATER POWER.



To find equivalent values, follow horizontal lines.



To find power generated connect quantity (sec. ft. or miner's inches) with head in feet by means of a straight edge, rotating to assumed efficiency to find actual power. To find power required for pumping reverse above operation.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER VII.

(Continued.)

Phantom Loads.

A method of testing watthour meters under full load conditions with a small consumption of power is to connect the potential circuit of the meter in the usual way and connect the current coils in series with the secondary of a small transformer especially designed for this purpose, the primary of the transformer being connected in parallel with the line as shown in Figure 92, therefore having the same impressed upon it as upon the potential coil of the meter. The resistance (R) is connected in series with the secondary windings, so that portions of it can be short circuited by means of suitable plugs or switches in order that

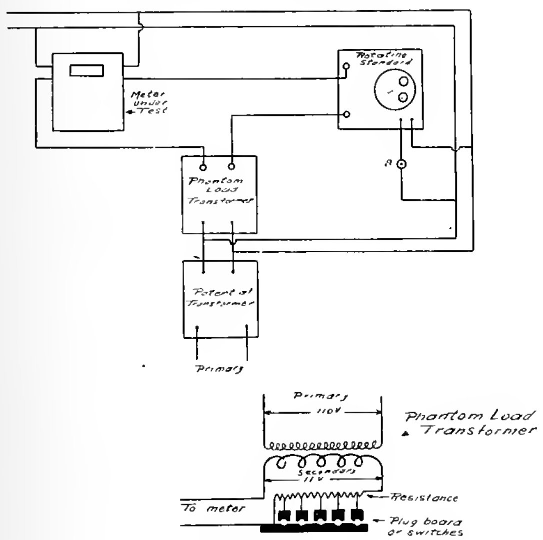


Fig. 92.

the desired current may be obtained. If the transformer is properly designed and the connections properly made, the secondary current flowing through the current coils of the meter will be approximately in phase with the impressed e.m.f. Full load current or desirable portions of full load current can be obtained for the meter under test, while the primary circuit takes only a very small amount of current from the line. This method of testing is especially convenient in testing meters on high potential circuits, as the potential transformers ordinarily used can also be made to supply the current for testing purposes through the agency of this "phantom load transformer." Such a transformer is usually designed to take about one-half ampere at 110 volts, while supplying 5 amperes to the meter under test.

The "phantom load transformer" is small and compact and can be easily carried from place to place; in connection with the portable rotating standard it furnishes a very complete set for testing the average size service meter. This transformer can be very advantageously used for testing meters on 50 per cent power factor where three-phase current is available, which is always the case where this adjustment is most important, namely on three-phase power circuits.

Let Figure 93 represent the vector diagram of the voltages in a three-phase system; then if the voltage AC is impressed upon the potential winding of the meter, and the primary of the phantom load transformer is connected across BA or BC, the current flowing in the secondary of the transformer, and therefore through the meter windings, will be 60 degrees out of phase with the voltage AC, or in other words, we will have a power factor of 50 per cent. One of the connections referred to will give a 50 per cent leading power factor and the other will give a 50 per cent lagging power factor, but it is better to make any necessary adjustments on lagging power factor, as the meter usually operates under this condition.

To distinguish between the connection for leading power and lagging power factor, most of the resistance in the secondary circuit of the phantom load transformer is short circuited and a reactance cut into the circuit. This reactance causes the current in the secondary to lag behind the secondary e.m.f., and when the primary of the transformer is connected across the proper lines to give a lagging power factor in the meter under test, the current will lag more than

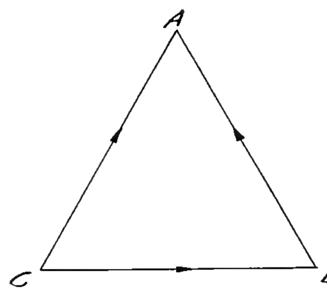


Fig. 93.

60 degrees, and the power factor will therefore be less than 50 per cent, while if connected to the proper lines for leading power factor the current will lag less than 60 degrees and the power factor will therefore be more than 50 per cent, thereby causing the meter to run slower when the transformer is connected across the proper lines for lagging power factor; as soon as this is determined the reactance is switched out, the power factor then being approximately 50 per cent lagging, after which the test may be continued.

The Knopp Method of Meter Testing.

A method in use by the Pacific Gas & Electric Co., of San Francisco, Cal., for testing watthour meters, and known as the "Knopp method" is as follows:

The tester is provided with a portable resistance box upon which is mounted an indicating ammeter, illustration of which is shown in Fig. 94 (a); he is also supplied with a stop watch which has a special dial that indicates millihours rather than seconds; the large hand (corresponding to the second hand of the ordinary stop watch) of this watch makes one revolution in 36 seconds, the dial being divided into 100 equal parts, each division representing 1-10 millihour. The resistance box has several coils, different combinations of which are used for different loads, each coil being adjusted to consume a definite amount of power at a predetermined potential. The box also has a variable resistance in series with the loading resistance, which

can be varied by means of a sliding contact provided for that purpose. By the use of this variable resistance the voltage drop across it may be made equal to the difference between the line voltage and the predetermined (100 volts) voltage, or in other words, so that this voltage is impressed upon the load resistance regardless of the value of the line voltage, which condition when reached will be indicated by the ammeter; that is, for any coil the ammeter will indicate a certain definite current. The potential tap for the watthour meter is connected inside of the resistance box so that the voltage impressed upon the meter will be the same as that impressed upon the load coils.

The load coils of the portable resistance box are adjusted to consume such an amount of power that the meter to be tested will, if correct, make one, ten or twenty revolutions in 36 seconds, or during one complete revolution of the hand of the special millihour watch. All that the meter tester has to do, therefore,

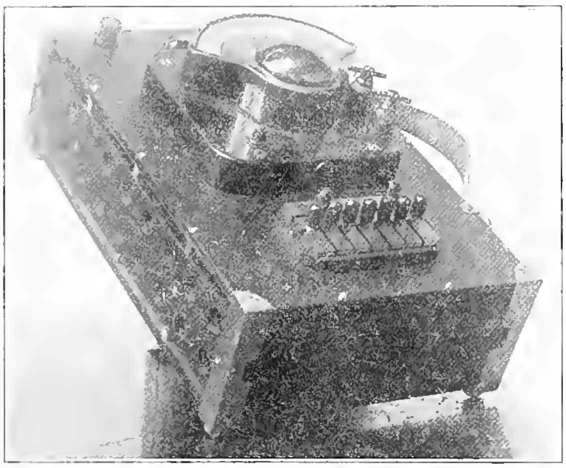


Fig. 94a.

is to connect in the box, obtain the proper current (by means of the various resistances), as indicated by the ammeter, and then note the time with the special stop watch of one, ten or twenty revolutions of the meter disc, depending upon which load the meter is being tested. From the reading of the stop watch the accuracy of the meter can be obtained directly without the use of a formula. If the watch has made exactly one revolution (for the load chosen), the meter is correct, while if the hand of the watch lacks two divisions the meter is approximately 2 per cent fast, or if the hand has made a complete revolution and two divisions past, the meter is approximately 2 per cent slow. This method of testing service watthour meters is convenient, since the outfit is light and compact, and it is also very quick.

Figure 94 (b) shows the diagram of connections of the "Knopp set," the name being derived from the patentee, Mr. Otto A. Knopp. For testing 110-volt meters, the plugs o, a, b and c are used, and for testing 220-volt meters the plugs o', a', b', c' and d are used. An example of the method of using this set is as follows: Suppose that it is desired to test a 5-ampere, 110-volt induction watthour meter having a calibrating constant of .3. The box is connected into circuit and a resistance is plugged in to give 600 watts; the variable resistance is adjusted until the ammeter indicates 0.600 ampere (1-10 of the current passing in shunt through the ammeter). The time for 20 revolutions of the disc is taken with the millihour watch; the time taken for the 20 revolutions should be the same as taken for one revolution of the hand of the watch. The percentage error will be indicated by the watch, as has already been explained. When the meter has been adjusted for full load (600 watts approximately), another resistance which takes 30 watts is plugged into circuit and the 600-watt load cut out; the variable resistance is adjusted until the ammeter indicates 0.30 ampere; if the meter is correct the disc will make one revolution while the hand of the millihour watch makes one revolution.

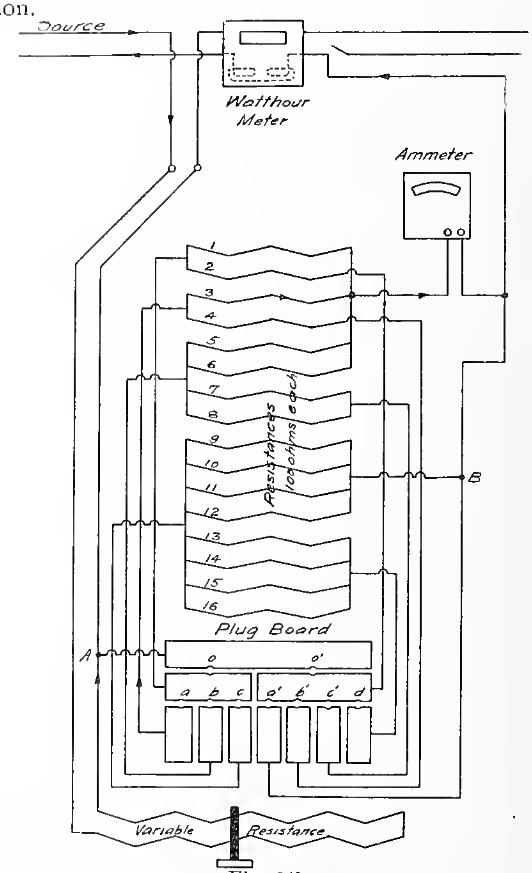


Fig. 94b.

The voltage of the circuit can be read with this outfit by switching in the 1-ampere resistance coil and cutting the variable resistance entirely out. The 1-ampere coil has a resistance of 100 ohms, and when the line voltage is impressed upon this resistance which is in series with the ammeter (which is 1.5 amperes capacity), the voltage of the circuit can be read directly from the ammeter. Thus if the line voltage is 100, the ammeter will indicate 1.0 ampere or if the line voltage is 110 the ammeter will indicate 1.10 amperes, etc.

By referring to the diagram (Figure 94), it will be seen that for the higher loads the ammeter is connected in shunt with the resistances, thereby taking only a part of the total current. By employing this method of connection, the ammeter is only used over the most accurate part of the scale while testing watt hour meters of different sizes and at different loads.

The Knopp millihour watch can also be used to advantage when testing with ordinary indicating instruments, since it has the advantage of simplifying the testing formula to some extent; the formula

$$P = \frac{R \times K \times 3600}{t}, \text{ becomes } P = \frac{R \times K \times 1000}{t'},$$

where t' is the time is millihours as read with the special stop watch.

When calibrating meters in the testing room with this special watch the load can be adjusted to be such a multiple of the disc constant that the disc will make one, ten or twenty revolutions for one revolution of the hand of the stop watch when the meter is correct. If the meter is not correct, the percentage inaccuracy will be indicated by the watch. Thus, if the meter is fast the watch hand will not quite make a complete revolution, while if the meter is slow the hand will make more than a complete revolution.

The number of divisions which the hand lacks of a complete revolution is the percentage by which the meter is fast. The number of divisions by which the hand has passed a complete revolution is the percentage by which the meter is slow.

In using this method of testing, the proper load is obtained from the following formula:

$$P = \frac{R \times K \times 10000}{t'},$$

$Pt' = R \times K \times 10000$; for one revolution of the stop-watch hand, $t' = 100$, therefore

$$100\ P = R \times K \times 10{,}000,$$
$$\text{or } P = R \times K \times 100.$$

For a 5-ampere meter having a constant of K=.3, and using one revolution of the disc for light load test gives P=30 watts. For full load test taking R=20, we will get P=600 watts.

Portable Testing Set for Direct Current Watt Hour Meters.

For outside testing of direct current meters the set as shown diagramatically in Figure 95, will be found to be convenient; it is compact and light, therefore easy for the tester to carry from place to place. The current is furnished for the smaller sizes of meters (5, 10 and 15 amperes), from an ordinary dry cell, and for larger meters from the improved type of Edison storage battery, the current being regulated by the plug resistances. The potential is taken from the line through the variable resistance which is regulated by a sliding contact block. Potential and current are supplied alike to the watthour meter under test and to the combination volt-ampere indicating meter shown at the top of the diagram. For convenience of testing, the volt-ampere meter has several potential and current ranges. The volt-ampere meter also indicates watts, the indication being shown on a scale directly beneath the intersection of the volt needle and the ampere needle. After selecting the proper current as indicated by the combination meter, the wattage is held constant by means of the variable potential resistance.

Adjustments.

In any type of meter if the actual value of P (in above formula) is greater than that expressed by the calibrating equation the meter under test is slow, and if this value is less the meter is fast. If we represent the power as registered by the watthour meter by P', and the true power as indicated by the standard by P, the error in percentage may be expressed by the equation, error $= \frac{P - P'}{P} \times 100$. In calibrating watthour meters it will be found to be more convenient to use the term "percentage of accuracy" or "correction factor" rather than the term "percentage error," since the former method involves less work in making the computations. For example:

$$\text{Percentage of accuracy} = \frac{P'}{P} \times 100,$$

$$\text{Correction factor} = \frac{P}{P'}$$

If the percentage of accuracy is less than 100 the meter is slow; if it is greater the meter is fast. If the correction factor is less than 1 the meter is fast, and if it is more than 1 the meter is slow.

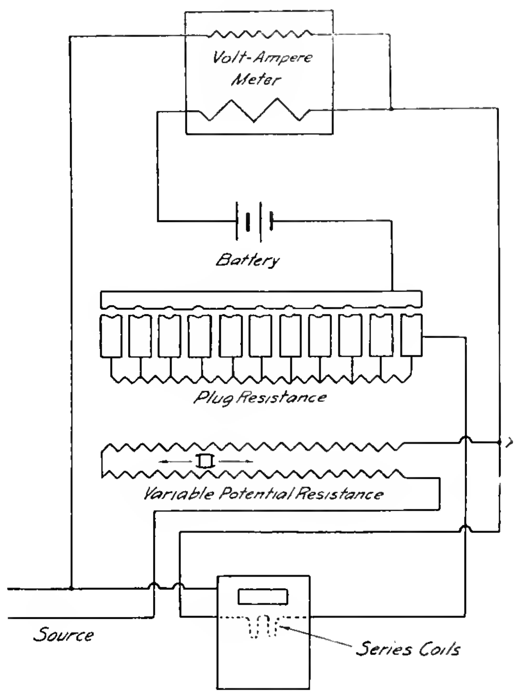


Fig. 95.

If the watthour meter under test is found to be inaccurate at or near full load, the retarding magnets should be adjusted until the meter registers correctly. If it is slow, the magnets should be moved in toward the center of the disc, which operation will increase the speed, while if the meter is fast the retarding magnets should be moved out toward the periphery of the disc.

If the meter under test is found to be slow on light loads, undue friction should be looked for and eliminated, and the light load adjustment (as previously explained for various kinds of meters) reset. If the meter is fast on very light loads, or if it "creeps," the light load adjusting device is very probably exerting too much torque, and its effect should be decreased until the meter is within 2 per cent accuracy on a 5 per cent load.

(To be continued.)

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PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Discharge of Impulse Water Wheels

The three limiting conditions which govern the power that may be generated by a water wheel are the head under which it is operated, the speed at which it may be run, and the quantity of water which it will discharge. As the head is fixed by the physiographic conditions, a matter of geologic relief, and as the speed is usually limited by the safe velocity of the generator, a matter of the strength of materials, the last condition is the only one which the wheel designer may increase. Several excellent methods of calculating turbine discharge have been devised, especially by the Germans, and are closely confirmed by experiment, but for the impulse type water wheel, few designers have investigated the influence of the angle of discharge and of the radial length of the bucket edge upon the wheel capacity. This lack has been admirably supplied by Mr. S. L. Berry elsewhere in these columns, and his conclusions are worthy of careful study.

Multiple Arch Dams

A notable contribution to the series of discussions on multiple arch dams that has recently been published in these columns is that of Mr. L. R. Jorgensen on another page of this issue. The first American dam of this type, embodying piers joined by vertical arches, was that built by Mr. John S. Eastwood at Hume Lake in Fresno County, California. Mr. Eastwood was the first American engineer who had the courage of his convictions to actually build a dam which so radically departed from recognized standards. Others had proposed such a possibility, but he demonstrated its practicability.

Improvement in engineering design is a matter of evolution. The ancient Roman mythology could conceive of a "Minerva springing full-panoplied from the brow of Jove," but modern experience has shown that it is only by gradual development that permanent structures are executed. The curved dam meets certain requirements for which the straight gravity type, its predecessor, is not adapted, particularly in economy of material. Likewise the multiple arch is an improvement on the single arch span which it succeeds, effecting even greater saving in material.

Mr. Jorgensen has prepared a number of designs, and draws comparison between several single arch dams, all one hundred and twenty-five feet high, but designed for spans varying from two hundred to six hundred feet, the latter being the economical limit for this type. He clearly demonstrates that they have a higher factor of saftey and contain less material than the usual straight model. He then shows that the multiple arch makes a yet greater saving in material and is subject to compressive stresses alone. It consequently needs no steel reinforcement. These conclusions corroborate Mr. Eastwood's original contentions and suggest that this type of structure should be more extensively used for moderate heights.

PERSONALS.

A. M. Hnnt has returned from a business trip to Portland.

G. W. Price has returned to San Francisco from Los Angeles.

F. H. Poss, of the Benjamin Manufacturing Company, is at Portland.

H. B. Vanzwoll, secretary of the Snnbeam Lamp Company, is at San Francisco.

H. E. Adams, general manager of the Stockton Gas & Electric Corporation, was a San Francisco visitor.

J. A. Herr, representing the Pacific Coast agency of the Sprague Electric Company, is in Southern California.

F. A. Cressey Jr., superintendent of the electric lighting system at Modesto, Cal., was at San Francisco last week.

Frank R. Schalch, traveling representative of the Electrical Review and Western Electrician of Chicago, is at Portland.

R. M. Durbin, formerly with the G. W. Prince Pump Company, is now chief engineer for the Ridge Land Company of Los Angeles.

C. R. Downs, of the Amador Electric Railway & Light Company, of Sutter Creek, Cal., recently spent a few days in San Francisco.

H. Vance Lane, president of the Rocky Mountain Telephone Company, of Salt Lake City, Utah, visited San Francisco last week.

F. C. Nelson, vice-president of the Tri-State Telephone & Telegraph Company of St. Panl, Minn., was a San Francisco visitor last week.

H. H. Noble, president of the Northern California Power Company, has returned from Shasta County, where he inspected some of his electric installations.

Guy W. Talhot, vice-president and general manager of the Oregon Electric Railway, Portland, Ore., has been elected president of the Portland Gas & Coke Company, Portland, Ore.

R. D. Holabird left San Francisco this week to attend the convention of the National Electric Lamp Association. There he will meet W. W. Briggs.

W. S. Barstow, of W. S. Barstow & Co., the New York firm which constructed the Oregon Electric Railway Line extending from Portland to Salem, stopped over two days at San Francisco on his way East, en route from Oregon.

Belvedere Brooks, vice-president and general manager of the Western Union Telegraph Company, who is making a tour of the Pacific Coast for the purpose of gaining information as to the needs of the service in the way of betterments, will spend several days in San Francisco.

E. N. Sanderson, of Sanderson & Porter, New York, spent a few days at San Francisco while making an extensive business tour of the country. He will next visit the Pacific Northwest, his firm having pnrchased the electric lighting and traction system at Aberdeen, Wash.

SAN FRANCISCO SONS OF JOVE.

At the regular bi-weekly lnncheon of the San Francisco Sons of Jove at the Techau Tavern, on May 19th, announcment was made of the new officers appointed by Statesman W. W. Briggs, as follows: A. E. Drendell, Jnpiter; W. S. Berry, Neptune; C. E. Wiggins, Mercury; S. P. Russell, Pluto; R. L. Phelps, Vulcun; C. C. Davis, Hercules; W .W. Hanbridge, Mars; A. E. Rowe, Apollo; F. H. Poss, Avrenlm. It is planned to hold a record-breaking rejuvenation on Angust 13th.

N. A. S. E. CONVENTION.

Following is the program for the seventh annual convention of the California State Association of the National Association of Stationary Engineers, to be held at Los Angeles, May 23rd to 28th:

Monday, May 23.

Arrival of delegates and opening exhibit at 2 p. m.

Formal opening of exhibit at 8 p. m.

Introduction of Mayor Alexander by Past National President Fred J. Fischer.

Address of welcome by the Mayor.

Response and opening of exhibit by State President J. N. Pyster.

Tuesday, May 24.

Exhibit hall open from 10 a. m. to 10 p. m.

Opening of State convention in banqnet hall of Angelns Hotel at 9 a. m.

Convention in session at 2 p. m.

Visiting exhibit in evening until 10 p. m.

Wednesday, May 25.

Balloon Route excursion to Hollywood, Palisades, Long Wharf, Santa Monica, Ocean Park, Venice and Redondo, where the plant of the Pacific Light & Power Company will be visited, leaving the Los Angeles-Pacific depot on Hill street at 9:30 a. m. Bathing and lnncheon at one of the beach resorts. Theater party in the evening for delegates and visitors.

Thursday, May 26.

Convention in session at 9 a. m.

Convention in session at 2 p. m.

Automobile ride for visiting ladies, tendered by ladies' auxiliary, N. A. S. E., at 10 a. m.

Social dance at Goldberg-Bosley Assembly Hall, Sixteenth and Flower streets, at 8:30 p. m.

Friday, May 27.

Convention in session at 9 a. m.

Convention in session at 2 p. m.

Reception for visiting ladies by ladies' auxiliary, N. A. S E., at Odd Fellows' Hall, 220½ South Main street, at 2:30 p. m.

Regnlar meeting of Los Angeles Association No. 2 and installation of State officers at 8 p. m., after which all members will visit the exhibit.

Saturday, May 28.

Excursion to Long Beach and basket picnic on pleasure pier, leaving Los Angeles from Pacific Electric depot, at Sixth and Main streets, at 10 a. m. Surf and plunge bathing and inspection of United States government $3,000,000 breakwater and harbor at San Pedro in afternoon.

Banquet at Hamburger Cafe at 8 p. m. and closing of exhibit.

Exhibit open every day from 10 a. m. to 10 p. m.

Band concert every afternoon and evening in exhibit hall.

PACIFIC COAST ELECTRICAL EXPOSITION.

The executive committee are pleased to announce to the exhibitors of the Pacific Coast Electrical Exposition that the date of opening of said exposition has been definitely set for August 20, 1910, (to continue for eight days) at the new Colisenm, Baker, Oak and Fell streets, San Francisco, Cal.

W. W. BRIGGS,
JOHN R. COLE,
J. A. VANDEGRIFT,
WM. L. GOODWIN,
ALBERT H. ELLIOT,
Executive Committee.

INDUSTRIAL

THE USE OF POT HEADS FOR CABLE TERMINALS.

The art of installing lead covered cables has been vastly improved within the last five years by the introduction of facilities for properly terminating such cables in the form of pot heads. Formerly the only means available for terminating a cable consisted in a lead sleeve left open at one end, or a

Fig. 1.

Fig. 2.

Fig. 3.

brass bell wiped to the lead sheath and filled with compound.

These devices were not all adapted to out of door conditions, and did not provide any means of disconnecting the conductors at the cable terminal except through a separate device such as a switch or cutout box.

The necessity for a pot head which was suited to outdoor conditions, and which permitted the circuit to be easily opened at the cable end, led the engineers of the G & W Electric Specialty Company of Chicago to develop the line of detachable porcelain pot heads which they have been placing among cable users for the past six years.

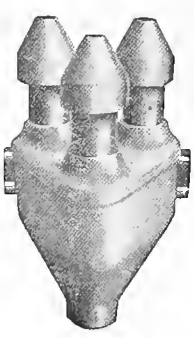


Fig. 4.

Fig. 5.

The use of a porcelain sleeve with an insulator type of cap solved the problem of exposure to the weather. The happy combination of suitable current carrying parts contained within the porcelain produced a device which is detachable; that is, without tools of any kind, an operating man may disconnect the circuit by the simple act of lifting the cap from the tube. When the circuit is to be closed the cap is replaced and the connection is simultaneously made. This form also permits the installation of this device in manholes, as the bell-shaped cap retains sufficient air to keep out the water in case the manhole should fill with water.

This is one of the distinctive features of the G & W line, the value of which should not be overlooked. The cost of cut-out boxes on outside lines and knife switches on inside work as disconnectives is entirely saved by the use of the

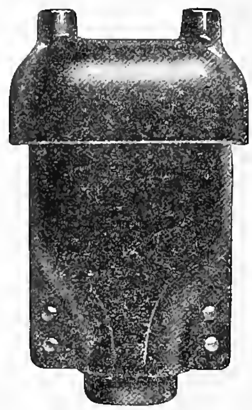


Fig. 6.

detachable types. It has been the aim of the company to provide an absolutely complete line of pot heads for light and power work. It therefore offers pot heads for single or multiple-conductor cables up to 10 conductor cables, detachable or non-detachable, combination pot heads and series cutouts, combination pot heads and subway cutouts and any other special forms which engineers may require up to 33,000 volts.

The pot heads for single-conductor are known as type "S" (illustrated in Fig. 1), suitable for cables up to 00, and the type "TS" (illustrated in Fig. 2), intended for cables larger than 00. The type "TS" is provided for any cable up to 1,000,000 c.m. The pot heads for multiple-conductor cables are known as form "L" for voltages up to 7500 (shown in Fig. 3), and form "M" for voltages from 7500 to 15,000 (shown in Fig. 4). Both of these types of pot heads are made for two, three or four-conductor cable.

Form "L" and form "M" pot heads are furnished with adapters by which the lower end of the pot head may be fitted

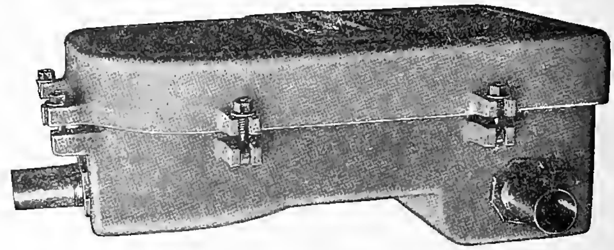


Fig. 7.

to any size standard wrought-iron pipe from 1½ to 3 in. inside diameter if desired. The station type of pot head (shown in Fig. 5) consists of a porcelain lid and band which is supported on a threaded iron collar so designed that it may be attached direct to the sheath of the cable. The combination pot heads are shown in Figs. 6 and 7; Fig. 6 being a combination pot head and series arc cutout. This device is small enough to be installed inside the base of a lamp pole and is no more expensive than the ordinary forms of absolute cutout which

do not provide any means of sealing in the ends of the cables from moisture. This device can also be installed in manholes or handholes, as it will operate when submerged. This cutout is also furnished for use simply as a cutout on overhead lines where the pot head feature is not required and is an absolute cutout in that the connections to the loop are entirely removed from the base which carries the circuit connections when the loop is disconnected.

The subway cutout (shown in Fig. 7) is designed to take an enclosed fuse or a disconnecting switch blade as may be desired. The lower part of the cutout is filled with compound after the cables are connected, thus providing an absolute seal against moisture getting into the cables. In addition to this the cover of the iron box is provided with a long overlap which

Fig 8.

prevents any water from getting into the box in case it is submerged. A rubber gasket in the cover prevents the circulation of moist air and thus preserves the arc smothering material in the enclosed fuse. These junction boxes are made for two, three or four-conductor cables and for either straight connections or half tap.

The type "S" and type "TS" pot heads are designed for voltages up to 15,000. For voltages from 15,000 to 35,000 the type "HS" is provided. The type "HS" for single-conductor cable is shown in Fig. 8. This also is made up for multiple-conductor cables in a form similar to the type "M."

Fig. 9.

In addition to their line of pot heads, this company also places on the market a malleable iron cap shown in Fig. 9, by which ground wires may be connected to ground pipes with a driving fit without making a soldered connection, the malleable iron cap being used as a driving head to protect the end of the pipe while it is being driven.

A CONVENTION EXHIBIT WORTH WHILE.

Following their usual custom, The Kellogg Switchboard & Supply Company provided exceptionally fine and instructive exhibits at the recent Kansas and Missouri conventions held at Topeka and St. Joseph.

The same exhibit apparatus was used at both conventions and an unusually large number of interesting features were shown. Altogether the exhibit contained three switchboards and a thoroughly representative assortment of telephones and smaller apparatus. A 200-line, two-position magneto board, fully equipped with line and cord and transfer circuits, together with calling and disconnect pilot lamps showed the perfection to which magneto equipment has been brought by the Kellogg Company. The cord circuits in this board were all of the improved double supervisory non-interfering type described in Kellogg Bulletin No. 32. It was shown that these cord circuits not only insure the absolute operation of ring-off drops, but that with them it is impossible for any party on any line to ring through the board and falsely disturb the bell of any party on any connected line.

Another feature of great interest was the demonstration of The Kellogg Company's new four- and eight-party Harmonic ringing apparatus for magneto exchanges. This system operates from dry batteries, absolutely without transformers. The only expense for central office equipment being a master key in each operator's position and a four frequency, inexpensive, wall mounting interrupter unit at the central office. The telephones used on this system can be any form of magneto instruments fitted with harmonic ringers. No condensers are required in the telephones; neither is it necessary to have direct current generators or other special features. The switchboard drop can be any resistance from 100 ohms up. The demonstration of this apparatus was most thorough and rigid and necessarily convincing. One of the four telephones had purposely been equipped with a 5-bar A. C. generator to demonstrate the impossibility of tapping any bells when calling central or ringing off. An artificial condition had also been set up for demonstrating the absence of induction on parallel grounded lines when ringing even with the 66-cycle current. The four-frequency interrupter unit was shown to operate absolutely sparkless, under all conditions, thus insuring indefinitely long life to the heavy platinum contacts with which the apparatus is provided.

A fifty-line lamp signal private branch hotel switchboard was shown arranged with simultaneous loud ringing and common talking keys for use in case of fire. This board was also arranged so that all incoming calls can be answered by means of the common answering key without touching any plugs and cords. A desk set on the hotel counter enables the night clerk to answer incoming calls wihout going to the board, the switch-hook in the desk set comprising in this case the common answering key. The popularity of this common-sense arrangement can be readily appreciated, since experience shows that over 95 per cent of all calls from hotel rooms do not result in completed connections, and in such cases it is only necessary for the guest to state his wants since the line lamp reveals his identity. This common answering circuit will no doubt find a wider application than hotel use.

PORTLAND SECTION, A. I. E. E.

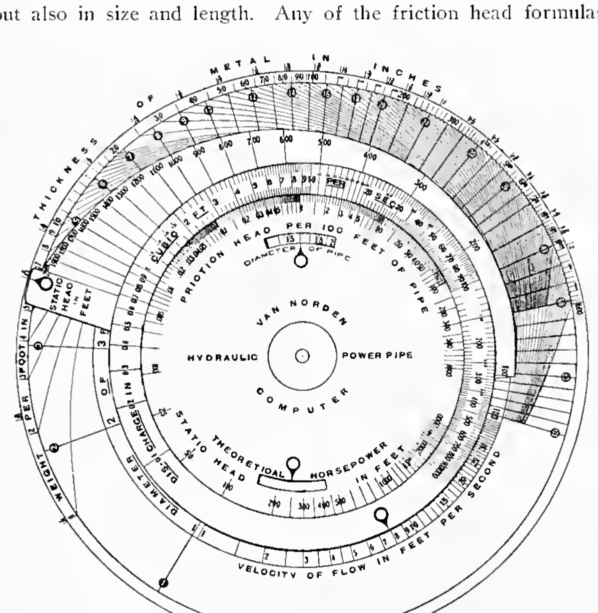
A meeting of the Portland Section of the American Institute of Electrical Engineers was held Tuesday, May 17th, at their assembly hall, Electric building. This was the annual meeting of the section, reports being made and officers for the ensuing year elected. A paper was presented by Mr. J. W. Newell on the "Handling of Telephone Traffic." A report of the San Francisco meeting was made by Mr. Paul Lebenbaum. Personal experiences in early electrical work were given by several of the older members.

PIPE CALCULATOR.

BY RUDOLPH W. VAN NORDEN.

This calculator is designed to quickly and accurately give the size and carrying capacity of long riveted steel pipes. The various functions are represented by logarithmic scales, so arranged, that, with one exception (calculation of the theoretical horsepower in the water), the scales may be placed to show all of the values at once.

There are eight values possible of determination, which can be found when two are known and the third assumed. They are: *volume* of the flow; *friction head* or loss per 100 ft. of pipe; *diameter* of the pipe; *static head* or the fall of the pipe; proper *thickness of metal* for any given head; *weight* per foot of pipe for any given thickness of metal; *velocity* of the flow; *theoretical horsepower* in the flow. These values bear to each other simple algebraic relations, with the exception of the formula for the *friction head*. This is based on the results of a large number of tests made on pipes with riveted seams and an interior lining of asphaltum or similar dip, varying not only in pressure applied, but also in size and length. Any of the friction head formulas



in use could be applied in the place of the one adopted, by changing the small scale for diameter, to conform with the formula.

To facilitate the arrangement of the scales in the computer, two of the functions represented have duplicate scales. These are *diameter* and *static head*.

There are three moving parts, two of them being discs and the third a sector. The stationary part, upon which the moving parts are mounted, has four scales; that for *velocity* of the flow, at the bottom; a scale giving *diameters;* outside of this a scale giving the *weights* of one foot length; and outside of the latter, one giving the various *thicknesses*. The scale giving weights is plotted to conform with a series of curved lines, which cross the lines of the diameter scale at points that arithmetically represent equal weights of unit lengths of pipe.

The sector indicates the proper thickness by means of a pointer. It contains also a scale representing the *static head*, the lines of this scale being terminated by the edge of the sector in such a way that the length of the lines is directly proportional to the head represented by the line. This is for the purpose of selecting the proper line, representing *weight*, and it is done by moving the sector so that the line representing head coincides with that showing *diameter*. The *weight* line intersecting the edge of the sector at this point is the one desired and its value is found by simply following out the line to its scale. These weight lines are all the same curve in respect to the center and could have been obviated by supplying a second sector, having an edge cut to correspond with the lines; it was deemed simpler to draw in the lines.

The larger dial contains a scale of *volume* of the flow in cu. ft. per second. It also contains a second *diameter* scale and a *theoretical horsepower* scale, the latter two appearing through windows in the small dial. A pointer on the large dial shows the *velocity*, when the value for *volume* is set to coincide with that for *diameter* (on the stationary scale).

The small dial contains the *friction head* scale. This is drawn to one-half the size of the *volume* scale and therefore its values represent the squares of those of the former and correspond to the numerator of the empirical equation for flow. A pointer on this dial indicates *diameters* on a scale seen through a window, when the line representing the unit *friction head* is made to coincide with that showing the *volume*. This *diameter* scale is drawn to dimensions bearing a relation to the *volume* scale of the exponent in the denominator of the formula used.

Another scale on the small dial is a duplicate scale to be used in connection with the *volume* scale, to determine the *theoretical horsepower*, which is shown through a window. While all of the other functions may be found by one setting of the calculator, this last computation is entirely separate.

The computer when set will therefore have the lines representing *diameter* (large scale), *static head* (sector), *volume* (large dial), *friction head* (small dial), all in one direct line, while the pointers will be properly directed to the *thickness* (only, of course, for the static head in question), *velocity*, and the edge of the sector will determine the unit *weight* (for the thickness shown).

To determine the *theoretical horsepower*, it is necessary to revolve the small dial until the proper value on its scale of *static head* coincides with that of *volume* on the large dial. The result desired is read directly through the window provided.

In setting the calculator, it may be found that the pointer on the sector shows an intermediate value for thickness. As sheet metal is supplied only in standard thicknesses it will be necessary to move the pointer to the nearest value given, before reading the unit weight.

The scale of *friction head* is carried to 1000 ft. to allow for calculations for the theoretical flow of water from pumps. The pressure required to force a given quantity of water through a given length and size of pipe can be instantly determined by finding the friction head for the total length and adding to it the static head on the pipe. This method does not, however, provide for sharp bends or entrance friction or the efficiency of the pump.

The values given as the proper thickness of metal are plotted on the assumption of an ultimate tensile strength of 50,000 lb. per square inch and a factor of safety of 4½. The tensile strength assumed is somewhat lower than is, as a rule, commercially encountered, but as the strength of riveted joints is somewhat less than the metal itself, the value used is a fair average for practically all conditions.

In calculating the thickness of a pipe, all the values from the bottom to the top, together with their weights, may be rapidly found as soon as the diameter is known. The profile of the pipe should be laid out on cross-section paper; the thickness at the bottom, where the head on the pipe is greatest, is determined, then, always working to the same diameter, move the sector, so that its pointer is placed consecutively at each thickness value and the static head and unit weight noted and plotted on the profile, remembering that any given size starts at the point plotted and runs up the pipe to the next point. After all the points are plotted, the lengths of the various sizes may be directly measured. The length of each section multiplied by the unit weight gives the weight of the section, and the sum of the weights of the sections gives, of course, the total weight of the pipe.

Long cast iron and wood-stave pipes may be calculated for

volume of flow, diameter, velocity of flow and friction head. Friction head formulas for these pipes are somewhat different than the one used for riveted pipe. In the case of cast iron, the computer is approximately correct, only for diameters of 16 in. or over, for smaller diameters the unit friction head values given are too high. In other words, a 10-in. cast iron pipe will have a lower friction loss than the computer would show for that size or for the same head it would carry a greater quantity of water than the riveted pipe. A number of multipliers are given to use with the friction head values, that might be found in the computer, which will give the proper values for cast iron.

Wood pipe has a much lower friction loss than either riveted or cast iron pipe and in figuring a wood pipe, the friction head values found must be multiplied by 0.50 to 0.70, depending on whether the pipe be old or new.

In working the pipe computer, which gives friction losses for units of 100 ft., the relations between these unit values, to the whole pipe line are generally derived by a simple mental calculation. This is sometimes confusing and the diagram is furnished to show these relations graphically.

The following equation is involved:

$$L \times F = f = p \times H, \text{ where,}$$

Co-ordinate Functions $\begin{cases} L = \text{Length of the pipe.} \\ F = \text{Friction loss per 100 ft. of pipe.} \end{cases}$

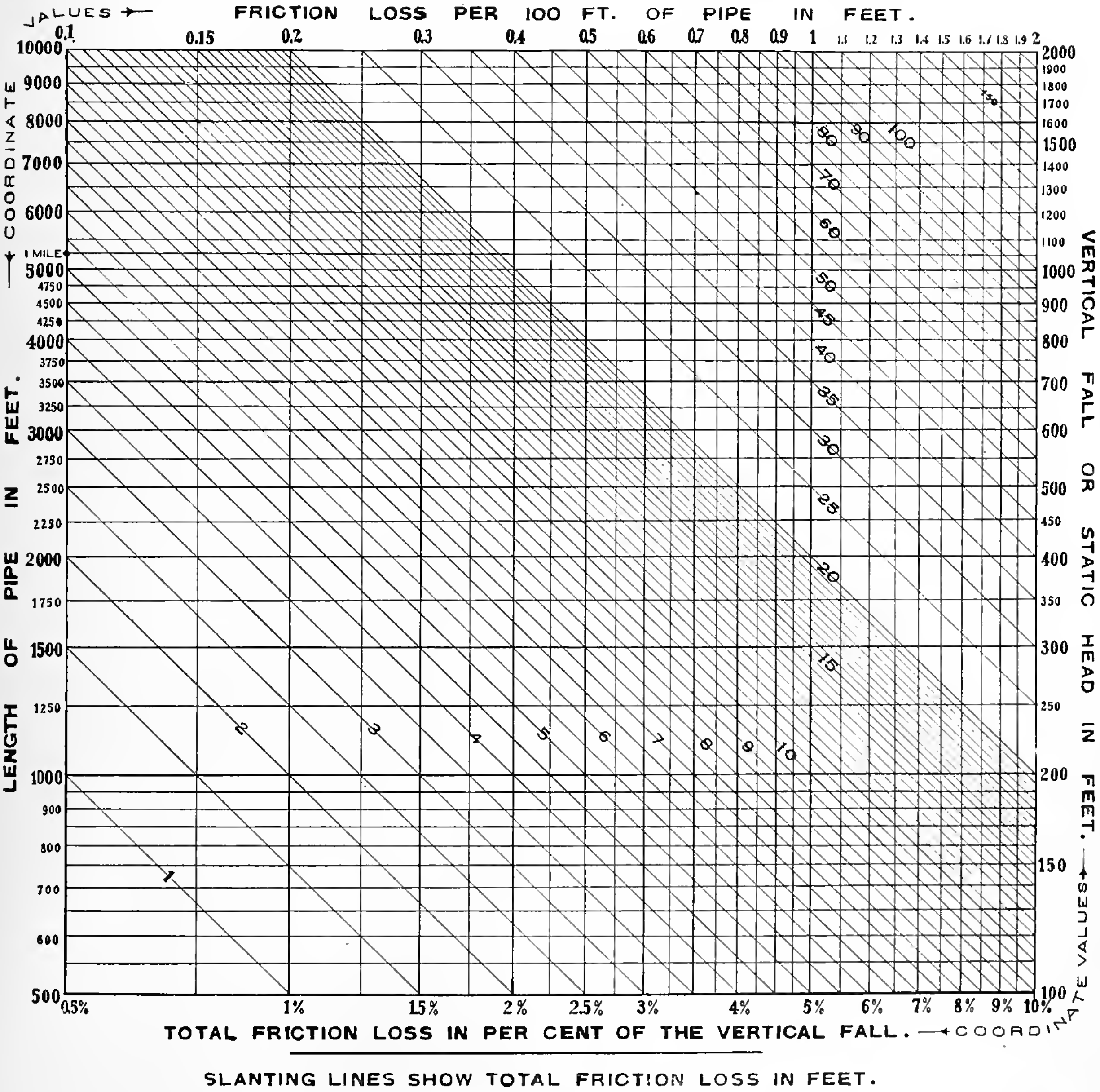
f = Total friction loss in the pipe.

Co-ordinate Functions $\begin{cases} p = \text{Percentage of the total head lost.} \\ H = \text{Fall or static head of the pipe.} \end{cases}$

The first two values are represented in the diagram by the horizontal and vertical lines, reading, respectively, from the left side and the top and must always be associated by reading to or from their intersections.

The last two values are also represented by co-ordinates, reading respectively from the bottom and the right side of the diagram.

The slanting lines tie the two sets of co-ordinates together by joining their intersections, thus making an assembly of all of the values in the equation. Incidentally, they also represent the values of the total friction head or loss.



SLANTING LINES SHOW TOTAL FRICTION LOSS IN FEET.

Diagram showing relations between unit friction loss and total friction loss for any length and fall of a pipe.

In using the diagram, two values are generally known and the third may be assumed.

Start with any two values which are co-ordinate. Find the point where their co-ordinates intersect. Bearing this point in mind, find the line representing the third value and, starting from the first point already located, follow the intersecting slanting line to where it cuts the line representing the third value. From this new point, the remaining intersecting co-ordinate line represents the fourth value sought. The slanting line which was followed represents the total friction loss in the pipe.

In order to meet all conditions, many more lines would have to be drawn in the diagram. These have been omitted to avoid confusion. Imaginary co-ordinate and slant lines to suit any values may be made by the use of a straight-edge held parallel to the horizontal or vertical or slanting lines, as the case may be.

Example. A pipe has a length of 3000 ft. and a fall of 900 ft.; it is shown by the computer to have a unit friction loss of 0.6 ft. per 100 ft. of length. What is the percentage of the total head lost?

From 3000 ft. on the left and 0.6 ft. on the top, follow their respective horizontal and vertical lines to their intersection; then follow the slanting line, to where it cuts the horizontal line from 900 ft. on the right side. Reading down the vertical line from this second intersection is 2 per cent, which is the answer. The value of the slant line which was used is seen to be 18 ft., which is the total friction loss.

Example. A pipe 4000 ft. long has a fall of 600 ft. The friction loss is assumed to be 5 per cent of the fall. What is the unit friction loss per 100 ft. of pipe?

Locate 600 ft. on the right and 5 per cent at the bottom. From the intersection of the horizontal and vertical lines respectively representing these values, follow the slanting line to where it cuts the horizontal line from 4000 ft. on the left side. From the intersection so formed follow the vertical line to the desired value at the top, which is 0.75 ft. The slant line followed shows the total friction loss to be 30 ft.

In the illustration, the computer is set to work out a specific problem, and following are two examples that will apply to this setting:

Example 1. It is desired to get the dimensions of a pipe which will have a total length of 3000 ft., the total fall being 500 ft. and the volume of the flow being 11 cu. ft. per second. It is desired to have a pipe large enough so that the friction loss will not be over 10 per cent of the total fall.

A glance at the percentage diagram shows that the unit loss per 100 ft. will be between 1.6 and 1.7 ft.

Start with the volume scale on the large dial and locate 11 cu. ft. per second. Turn the small dial until 1.6 on the friction head scale is in line with the first value. Reading through the window, the pointer shows a diameter of 16 in.

Now move the sector until the line showing 500 ft. static head is in line with the 11 cu. ft. on the volume scale and also in line with that showing a diameter of 16 in. on the large diameter scale. The computer is now set; the pointer at the bottom of the large dial shows the velocity of flow to be 8 ft. per second; the pointer on the sector shows the proper thickness where the head is 500 ft., to be 5/32 in. and the curved line starting where the edge of the sector is in contact with the 16-in. diameter line, indicates a unit weight of 30 lb. per foot of finished pipe.

Next, revolve the small dial until the value of 500 ft. in the static head scale thereon is in line with 11 cu. ft. per second on the volume scale and through the window may be read the theoretical horsepower, which is 640. This value must, of course, in order to get the output of a water-wheel, be multiplied by the efficiency of the wheel.

Example 2. There is a quantity of hydraulic-mining pipe which it is desired to use; the diameter is 16 in. and the thickness of the heaviest of it is 5/32 in. There is available 11 second-feet of water (equal to 440 hydraulic-miner's inches or 550 statute-miner's inches). Find the head which may be safely used and the loss by friction which will occur.

Place the pointer of the sector at 5/32 in. In line with 16-in. diameter, the head is shown to be 500 ft. Turn the large dial until 11 cu. ft. is in line with the head and diameter lines. The pointer on the small dial shows the loss per 100 ft. to be 1.6 ft. and the velocity to be 8 ft. per second.

Now that the safe head has been determined, the length of the pipe may be estimated from a knowledge of the ground. If this is found to be 3000 ft., the total friction loss (from the diagram) is seen to be slightly less than 10 per cent.

In working out the pipe problem it may be necessary to make a number of assumptions for either velocity or allowable friction loss to determine the most economical pipe or the one best suited to the conditions, but in any case the computer will be found to be rapid and as accurate as the ordinary slide rule.

NEW CATALOGUES.

Bulletin No. 388, from the National Brake & Electric Company, exhibits different types of air valves for motormen's use.

Bulletin G, from the Lord Electric Company, 213 West Fortieth street, New York, is devoted to Earll Trolley Retrievers and Catchers.

Number Four of "Work Done" by Westinghouse, Church Kerr & Co., shows the wide range of engineering activities for which they are consulting engineers.

Sprague Flexible Steel Armored Hose is illustrated and described in No. 516 from the Sprague Electric Company. This is intended for either compressed air or steam and is especially durable and flexible.

The traffic department of the Spokane & Inland Empire Railroad Company, have issued a beautiful booklet about Hayden Lake, Idaho, on the company's lines. Typographically and pictorially this is an artistic gem.

Westinghouse Electric Fan Motors for 1910 are attractively portrayed in three handsome brochures from the Westinghouse Electric & Manufacturing Company. Folder No. 4100 is devoted to alternating current fan motors. Folder No. 4101 to direct current, and Circular No. 1165 gives more detailed information on both types.

D. & W. Fuse Company, Providence, R. I., have issued a supplement to their Price List No. 12A, covering their latest types of secondary fuse boxes and service switches and transformer and junction cut-outs, for both aerial and subway lines; also large capacity fuses up to 1,000 amperes, which they have never listed before. In circulars 112 and 113 will be found a complete description of the boxes referred to.

TRADE NOTES.

The Western Wireless Equipment Company has recently been appointed the Pacific Coast agents for the Wireless Specialty Apparatus Company of New York. They will control the Coast output of the perikon, pyron and silicon detectors and the 1-P-76 complete receiving sets, that are being used extensively by the navy to prevent interference. The specialties of the Eastern concern will be used in all of the equipments of tne Western Wireless Equipment Company.

The Ohio Brass Company of Mansfield, Ohio, announces that it recently purchased a controlling interest in the insulator pottery at Barberton, which for the past two years has been making the O-B Hi-Tension porcelain insulators sold exclusively by it. Active management of the insulator pottery has been taken over by the officers of The Ohio Brass Company, and under the new arrangement the company, with Mr. G. A. Mead, previously chief Engineer of The Ohio Brass Company, in active charge at pottery, expects to put into effect a system that will increase the rate of production materially, thus keeping pace with the great amount of business being received. All orders and inquiries will be handled from the main office of The Ohio Brass Company at Mansfield, Ohio, as heretofore.

NEWS NOTES

INCORPORATIONS.

CONNELL, WASH.—The Connell-Kahlotus Telephone Company has been incorporated for $2,000 by E. F. Redd.

SALTESE, MONT.—The Saltese Electric Light & Water Company has been incorporated for $10,000 by H. E. Rogers.

STANWOOD, WASH.—The Stanwood Light & Power Company was incorporated recently with L. F. Query as trustee.

SAN FRANCISCO, CAL.—The Central Power Company has been incorporated by J. J. Lermen, S. D. Woods and R. W. Dennis, with a capital stock of $50,000.

SAN FRANCISCO, CAL.—The Pacific Power Company has been incorporated by G. E. Anderson, G. W. Hendry and James McNab, with a capital stock of $1,000,000.

SANTA FE, N. M.—Incorporated: The Cimarron Water Company, with a captial of $60,000. The directors are: G. H. Webster and W. C. Hoffman of Cimarron and W. W. Studley of Raton.

SAN MATEO, CAL.—The rumor that the San Mateo Water Company had taken over the holdings of the Burlingame Water Company was practically authenticated when the Peninsular Water Company filed articles of incorporation in Redwood City. The incorporators of the new company are the same as of the San Mateo Water Company—Joseph Levy, Wm. F. Turbull, H. N. Royden, J. A. Foster and Chas. N. Kirbride. The capital of the new corporation is $1,000,000.

ASOTIN, WASH.—Articles of incorporation have been filed with the County Auditor for the Clarkston Irrigation Association, with a capital stock of $9,000, with the following stockholders: Geo. W. Balley (trustee), L. K. Alderson, C. Evans, F. E. Brown, E. Winders, W. F. Jones and C. McNary. A second article has been filed by the same stockholders, this company to be known as the Grande Ronde Power Company, with a capital stock of $1,000,000. The company will derive electric power enough at the mouth of the Grande Ronde River to furnish power to electric railways and other use.

TRANSMISSION.

LONG BEACH, CAL.—The Mercerea Construction Company has begun driving piles for the construction of the $2,000,000 Edison power plant on the harbor west of the drawbridge.

PHOENIX, ARIZ.—Los Angeles and Eastern people have organized a company, with a capital of $2,000,000, to build a dam at Striped Canyon, near the confluence of the Big Sandy and Santa Maria creeks. It is estimated that this dam will primarily create more than 3,000 electric horsepower, which will be carried to various mining camps in Mohave and Yuma counties.

ALAMEDA, CAL.—The city of Alameda may close down the municipal plant in the day time and get a supply of current from the Great Western Power Company, as the city electric commission declares the municipal plant is operated at a loss in day tlme. Mayor Noy states that a current was purchased from the power company it would in no way do away with the municipal plant, as the current during the night would be supplled by the city plant.

BOISE, IDAHO.—Capitalists associated with the Hill interests will build a power transmission plant on the South Fork of the Clearwater River, over five miles from the town of Grangevllle. Walter Hovey Hill, the engineer who is handling the proposition, has stated to the Hill interests that the proposed plant could generate 5,000 horsepower at that site to start with, and that additional plants can be built on other sites when the additional power is needed.

NEVADA CITY, CAL.—The Northern Water and Power Company, which owns a system of storage reservoirs in the mountains north of this city, will commence operations upon the Sawmill Flat reservoir. It is the intention of the company to raise this dam to increase its storage capacity. It is hoped to complete the work during the present season. The Middle Yuba Hydro-Electric Power Company also expects to begin operations shortly on their power scheme on the Middle Yuba below Graniteville. Flumes, ditches, reservoirs and a power-house will be constructed. It is the aim of the company to supply Alleghany with light and power.

QUINCY, CAL.—H. O. Lague, engineer and manager of the Feather River Power and Development Company, is in Quincy on business connected with his company, which is engaged in developing a hydro-electric power proposition on the Middle Fork of Feather River, below Nelson Point. The project planned includes the erection of three plants capable of producing, under natural conditions and without the assistance of storage reservoirs, a total of about 5,000 hp. It is estimated that the total drop to which the volume of water in the Middle Fork would be subjected in its course through the chain of plants would be 3,000 feet. The three points of diversion proposed are at Nelson Point, the mouth of the Onion Valley Creek, and at or near the mouth of the South Branch.

TRANSPORTATION.

LOS ANGELES, CAL.—The City Council has granted the petition of Robt. Marsh for a street railway franchise on Thirty-ninth street, from Vermont avenue to Western avenue.

BAKERSFIELD, CAL.—The Power Transit & Light Company has made application to the Board of Trustees for a fifty-year franchise for a single or double-track railroad in the city of Bakersfield.

CARSON CITY, NEV.—Ogden Mills, president of the Virginia and Truckee Railroad, who recently completed an inspection of the Virginia and Truckee Road, states that the work of extending the line to Bridgeport, Cal., will not be started this year.

COLUSA, CAL.—The Northern Electric Railway Company has filed a certified copy of its articles of incorporation with the County Clerk of Colusa County. These papers give the company power to build an electric road from Marysville to Colusa, a distance of thirty miles.

ALBANY, CAL.—G. W. McDowell, right-of-way agent; G. F. Nevans, traffic manager; H. Allen, attorney, and J. F. Richardson, civil engineer, representing the Oregon Electric, have applied to the City Council of Albany for a 25-year franchise for the extension of the line through Albany. The road will be in actual construction within two years.

LOS ANGELES, CAL.—Gen. M. H. Sherman and E. P. Clark no longer have their minority interest in the Los Angeles Pacific Railway, their holdings having been taken over by the Southern Pacific Railroad, which corporation has had a controlling interest in the property since 1905. Although the property has been under the nominal direction of Sherman and Clark since last November, when their holdings were taken over by the majority interest, the Southern Pacific has maintained a close supervision, and no new expenditures have been made without the authority of the Southern Pacific.

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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VOL. XXIV NO. 22 SAN FRANCISCO, MAY 28, 1910 PER COPY, 10 CENTS

FOR INDEX TO ADVERTISEMENTS SEE PAGE EIGHT

The Pacific Gas and Electric Company

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TO

Place.	Population.	Place.	Population.	Place.	Population.	Place.	Popalatina.
Agua Caliente	50	Drytown	100	Mare Island	500	San Andreas	200
*Alameda	27,000	Durham	500	Martell	25	San Anselmo	2,500
**Albany	800	‡Dutch Flat	400	Martinez	5,000	San Bruno	1,500
†Alta	200	**Easton	500	**Marysville	6,250	San Carlos	100
Alvarado	200	**East San Jose	1,500	Mayfield	1,500	**San Francisco	450,000
Amador	200	Eckley	20	**Menlo Park	1,500	**San Jose	40,000
Antioch	3,000	Emerald	50	Meridian	300	San Leandro	4,000
†Auburn	2,050	Elmhurst	2,500	**Milbrae	300	San Lorenzo	100
Barber	200	Elmira	150	Mill Valley	4,500	**San Mateo	7,000
**Belmont	600	El Verano	100	Mission San Jose	500	San Pablo	1,000
Belvedere	350	**Emeryville	2,000	Mokelumne Hill	150	**San Quentin Prison	1,600
Benicia	2,500	Encinal	20	Mountain View	2,500	**San Rafael	6,000
**Berkeley	42,000	Fairfield	800	**Napa	6,000	Santa Clara	8,000
Big Oak Flat	150	** Fair Oaks	250	†Nevada City	4,000	Santa Cruz	10,000
Biggs	750	Fitchburg	250	Newark	700	**Santa Rosa	8,000
Black Diamond	500	Folsom	1,500	‡Newcastle	600	Saratoga	200
Brentwood	200	*Fresno	35,000	New Chicago	25	Sausalito	3,000
Brighton	100	Glenn Ellen	500	Newman	1,000	Sebastopol	2,000
Broderick	500	Gold Run	100	Niles	800	Selby	100
‡Brown's Valley	50	Grafton	350	**Oakland	230,000	Sonoma	1,200
**Burlingame	5,000	†Grass Valley	7,000	Oroville	2,500	South San Fran.	2,500
Byron	200	Gridley	1,800	Orwood	50	Stanford Univ.	2,000
Campbell	1,000	Groveland	50	Pacheco	200	Stege	100
Cement	1,500	Hammonton	500	**Palo Alto	6,000	‡Stockton	25,000
‡Centerville	20	Hayward	4,000	‡Penryn	250	Suisun	1,200
Centerville	500	Hollister	3,000	Perkins	200	Sunnyvale	2,000
**Chico	13,000	Ione	900	**Petaluma	6,000	Sutter Creek	2,000
**Colusa	2,700	Irvington	1,000	Peyton	250	Tiburon	100
‡Colfax	400	Jackson	2,000	**Piedmont	2,000	Tormey	150
Colma	500	Jackson Gate	50	Pinole	1,500	‡Towle	200
Concord	1,500	Larkspur	950	Pleasanton	2,000	Tracy	1,200
Cordelia	150	Lawrence	100	Port Costa	600	Vacaville	2,500
Corte Madera	350	Kennedy Flat	50	**Redwood City	3,500	**Vallejo	12,000
Crockett	2,500	Kentfield	200	Richmond	10,000	Vallejo Junction	10
Crow's Landing	375	‡Lincoln	1,500	Rio Vista	200	Walnut Creek	350
Davenport	1,000	‡Live Oak	200	‡Rocklin	1,050	Wheatland	1,400
Davis	750	Livermore	2,250	Rodeo	100	Winters	1,200
Decoto	350	‡Loomis	150	‡Roseville	345	**Woodland	3,500
Dixon	1,000	Los Altos	200	Ross	900	Yolo	350
Dobbins	50	Los Gatos	3,000	***Sacramento	52,000	**Yuba City	1,900

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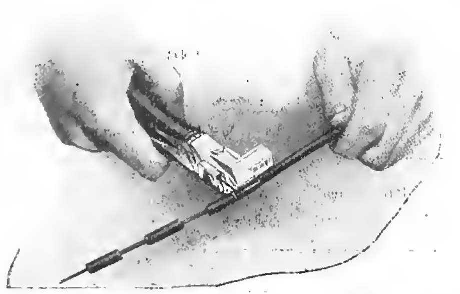

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SAN FRANCISCO

JOURNAL OF ELECTRICITY
POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXIV SAN FRANCISCO, MAY 28, 1910. NUMBER 22

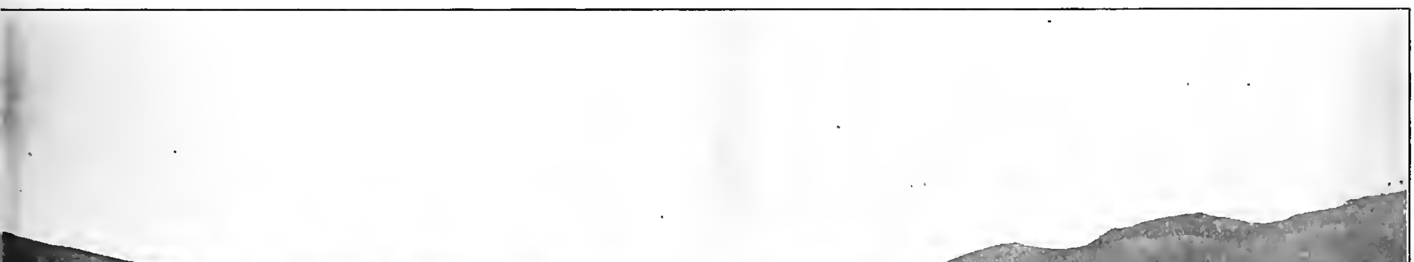
THE DEVELOPMENT OF OIL-GAS IN CALIFORNIA

BY E. C. JONES.

E. C. Jones.

The various methods of distilling oil into gas in externally heated vessels date back to the discovery of petroleum. In nearly all of these processes the oil was subjected to a comparatively low temperature in either iron or clay retorts, with unsatisfactory results attended by much trouble. Not until the introduction of generators and superheaters for water-gas making was it attempted to decompose oil in contact with highly heated surfaces of refractory material in internally heated vessels. Then the oil was looked upon as an enricher of other gases, and subservient to these dilutent gases, which took the name of water-gas. The name of oil-gas with its unctuous suggestion is apt to awaken unpleasant memories in the minds of the older generation of gas men, who experimented with the many ways of stewing oil in iron retorts. For this reason oil-gas as well as water-gas is badly named. The oil-gas of California is so much like enriched coal-gas that no chemist could identify it as having been made from oil.

The high price and scarcity of petroleum in the



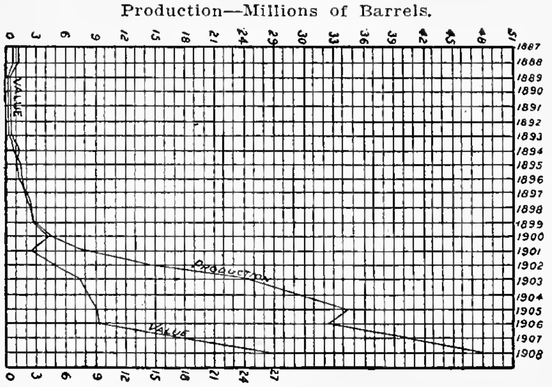
General View of Martin Station at Visitacion Valley, near San Francisco—The First Large Producer of Oil-Gas in the World.

populous and large gas-producing districts of the United States have probably deferred the invention and use of oil-gas apparatus. But the discovery of vast quantities of oil in California made it an economic necessity. The full extent of this necessity and the reasons for completely changing the method of making gas in California and the abandoning of all other generating apparatus will be better understood by referring to the following table, showing the quantity and value of petroleum produced in the State during the past twenty-one years, and to a chart, showing the relation of quantity to value.

PRODUCTION OF PETROLEUM IN CALIFORNIA.

Year	Quantity, bbls.	Value	Value a bbl.
1887	678,572	$1,357,144	$2.00
1888	690,333	1,380,666	2.00
1889	303,220	368,048	1.21
1890	307,360	384,200	1.25
1891	323,600	401,264	1.24
1892	385,049	561,333	1.45
1893	470,179	608,092	1.29
1894	783,078	1,064,521	1.35
1895	1,245,339	1,000,235	.803
1896	1,257,780	1,180,793	.90
1897	1,911,569	1,918,269	1.00
1898	2,249,088	2,376,420	1.05
1899	2,677,875	2,660,793	.99
1900	4,329,950	4,152,928	.95
1901	7,710,315	2,961,102	.38
1902	14,356,910	4,692,189	.32
1903	24,340,839	7,313,271	.30
1904	29,736,003	8,317,809	.27
1905	34,275,701	9,007,820	.26
1906	32,624,000	9,238,020	.28
1907	40,311,171	16,783,943	.41
1908	48,306,910	26,566,181	.54

Production—Millions of Barrels.



Value—Millions of Dollars.

Yearly Production and Value of Petroleum in California.

Until 1884 coal-gas was made in California exclusively from coals brought from Australia as ballast for English wheat-carrying ships, and coals from the State of Washington and from Vancouver Island. The finding of oil in considerable quantities encouraged the making of water-gas as an auxiliary to coal-gas, so that in 1899 there were in California one crude oil water-gas works, ten (Lowe) carburetted water-gas works, eighteen coal-gas works, five oil- and air-gas works.

This was the beginning of oil-gas making, and during the year of 1899 there were 2,677,875 barrels of petroleum produced in California. For some years after this the production of oil doubled each suceeding year, and the difficulty of finding a profitable market for this enormous increase caused a corresponding drop in the price of oil. This was the incentive for having oil displace all other crude materials for gas making.

Today there are in California fifty-six oil-gas works, and in connection with these are three plants for manufacturing water-gas from lampblack residual of oil-gas making, one small coal-gas works, and one oil and air gas plant.

The credit for discovering this new method of making gas and the invention of suitable apparatus for use in making it belongs to L. P. Lowe of San Francisco, who anticipated the eventual use of oil-gas long before the plentiful supply of cheap oil warranted its commercial use on a large scale. He constructed several small plants in different parts of California, and September 1, 1902, completed the erection of and started an oil-gas plant in the works of the California Gas and Electric Corporation in Oakland. This was the first adoption of the new process to the supply of gas to a large city, and was the basis of experiments from which the present oil-gas apparatus has developed. Improvements made it possible by September 11, 1904, to supply the entire output of Oakland.

Early Type of Apparatus.

The first type of oil-gas apparatus was constructed with the idea that extremely high heats for decompoing the oil produced the best results. It is, of course, understood that a generating apparatus consists of two or more shells filled with checker brick, and as there is no solid fuel used, there is an absence of boxes and grate bars found in the ordinary water-gas generators. The checker brick are heated by oil injected under pressure with steam in company with a blast of air for combustion. No secondary air was used in the first types of apparatus, and it was quite impossible to control the heat in different parts of the machine. The oil for heating was usually injected at the bottom of the generator under an arch or series of arches.

There is a temptation to use arches in oil-gas generators over the combustion chambers for supporting checker brick, but it was soon discovered that no arch can be constructed that will withstand the blow-pipe effect of the oil flames, and the most carefully constructed arches made of the best material obtainable lasted but a few days or weeks.

It was first supposed that burning oil in a primary shell and passing the products of combustion over checker brick in a second shell without the use of secondary air coated the checker brick in the second shell with particles of lampblack deposited from the decomposed oil, and that during the succeeding run the steam admitted with the oil for gas making was converted into carbonic oxide and hydrogen in contact with these lampblack-coated surfaces.

The high temperatures at first employed destroyed a large quantity of oil, resulting in a diminishing yield of gas at but low candlepower, and in the production of a large amount of lampblack. The yield of lampblack amounted to more than thirty pounds for each thousand cubic feet of gas made. As this lampblack was the result of decomposed hydrocarbons, the hydrogen which has been linked to this carbon remained in the gas as free hydrogen.

Following is an analysis of early oil-gas:

Composition.	Percentages.
Heavy hydrocarbons	6.2
Marsh gas	25.6
Hydrogen	62.4
Carbonic oxide	3.0
Carbonic acid gas	0.2
Oxygen	0.4
Residual nitrogen	2.2
Total	100.00

Specific gravity, .303.
Net British Thermal Units, 624 the cubic foot.

The candlepower was 18.6. This gas was made in Oakland, California, in September, 1902, and is a fair sample of the oil-gas of those days, which was produced in highly heated generators with no means of regulating the heat, without wasting it. This gas, burned through an open tip, had every appearance of coal-gas of the same candlepower, the flame being of the same size, but of apparently greater brilliancy than coal-gas. The small percentage of carbonic oxide is good evidence that little or none of the steam admitted with the oil was decomposed. This is borne out by the fact that carbonic acid gas was 0.2 per cent, and as the gas was purified by oxide of iron none of the carbonic acid was removed by purification.

The low specific gravity .303 is, of course, due to the large percentage of hydrogen, and it is undesirable for the reason that there is a greater waste in use by consumers, and the increase in street-main leakage is noticeable.

The specific gravity and hydrogen content bear so close relationship to each other that all oil-gas containing 50 per cent or more of hydrogen is of specific gravity .4 or less, and oil-gas containing less than 50 per cent of hydrogen has a specific gravity of .4 or more.

The high temperature in the generators created troubles of about the same character and disagreeable qualities as those encountered where extreme high temperatures are used in regenerative coal-gas benches.

Tar, which under other conditions would have passed over to the scrubbers and been condensed in the ordinary way, was made into pitch. The pitch mingled with the particles of lampblack and formed solid stoppages in the wash-box, so that it was no uncommon experience to make gas twenty hours one day, devoting four hours to cleaning the wash-box and down-take pipe, while on the following day twenty hours would be devoted to cleaning the wash-box, with four hours' time remaining for gas making. The lampblack recovered as a by-product was made in such large quantities that after a generous amount of it had been used for firing boilers about the works there remained a sufficient quantity to become a nuisance.

The lampblack as it is removed from the separators contains from 50 to 60 per cent of water, and it is necessary to drain off the water until the water content is reduced to about 30 per cent before the material is fit to be used as boiler fuel. The large amount of water in the lampblack prohibits the use of any of the briquetting presses that are successfully used for briquetting other dry materials, or materials containing a small amount of binder.

To add to the discomforts of making gas in this way, the wash-box was so constructed that it retained a large amount of lampblack within itself, while the lampblack separator permitted large quantities of lampblack to overflow and be wasted. This waste was not deplored so much on account of the loss in money as from the fact that the drainage from the gas works was usually emptied into a river or bay, and the State Fish Commission complained of the pollution of the water. With these discouragements and the meager amount of knowledge of the work actually being done, the construction of oil-gas apparatus in large units for the supply of gas to cities to the exclusion of all other kinds of gas seemed dangerous, and the task was unattractive.

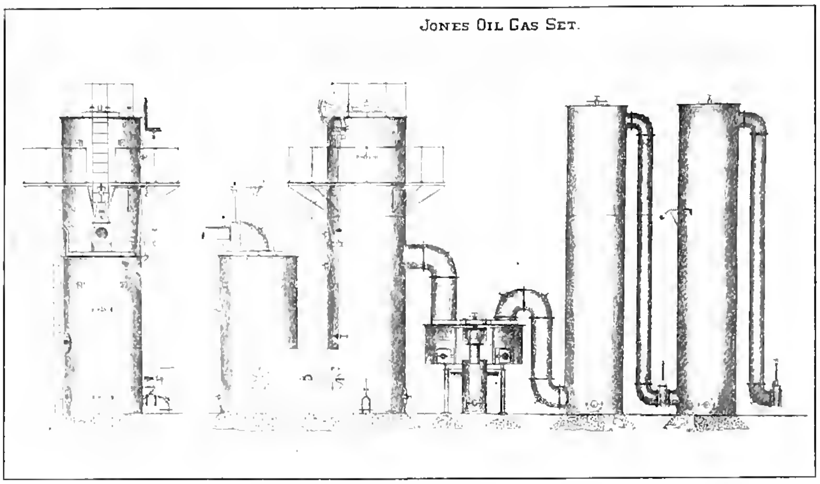
Oil-gas machinery had been constructed of all kinds and sizes with hardly two alike, and it was first necessary to design an apparatus applicable to both large and small works, and make standard every detail of it, thus accomplishing in three years the same results that have required thirty years of hard work with water-gas apparatus.

The first important improvement was the eliminating of brick arches over the combustion chamber, and the substitution of corbel work at the top of both generators in place of arches. To provide a combustion chamber without arches it was necessary to construct a pair of generators in the shape of a letter U, one leg of the U being much longer than the other. The shorter of the two shells is used as a primary generator and the air blast is admitted downward through the center of the top of this generator.

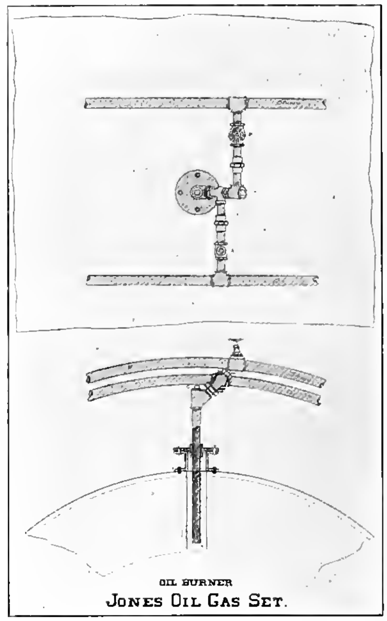
At first the oil was fed through burners pointing downward through the top of the primary in the same direction as the air. But it was found that better results were obtained by placing the oil burners in a circle around the side of the generator near the bottom of the corbel work, thus injecting the oil at several points around the circle at right angles to the direction of the air. The top of the primary thus becomes a combustion chamber, and there is no sharp impact of oil flame against any part of the brickwork. To assist a proper understanding of the apparatus, a few illustrations have been prepared; these were photographed from working drawings of a modern and satisfactory oil-gas set, as well as from apparatus now in operation.

Sequence of Operations.

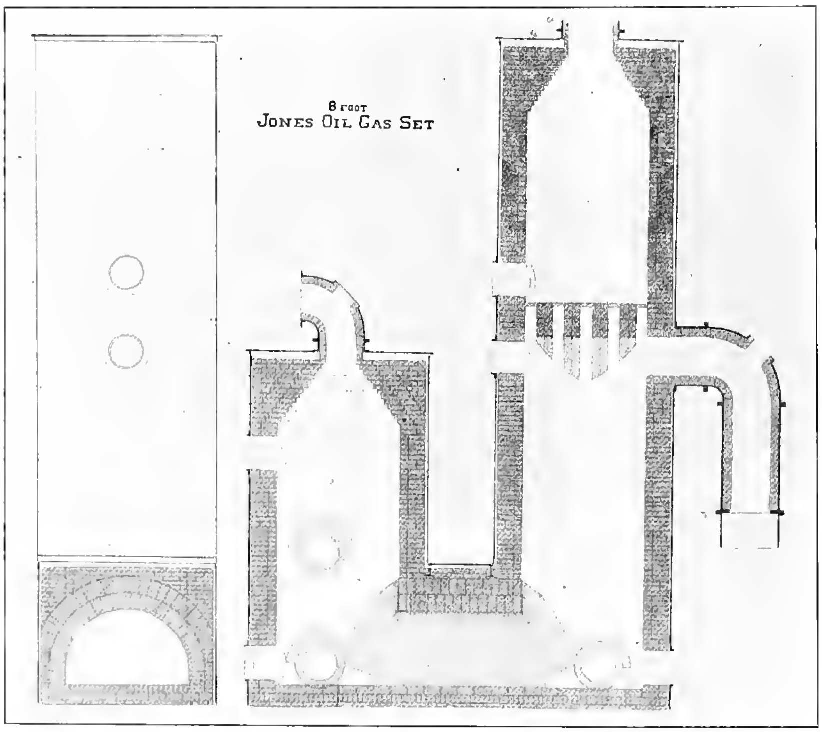
The sequence of operations in blasting and making gas, after the brickwork has been brought to a temperature that will ignite petroleum, begins with the opening of the stack valve at the top of the secondary generator and is followed by the opening of the air blast at the top of the primary generator and the admitting of oil and steam through the heating burners at the top of the primary generators. The set is entirely operated from the floor, the gas-maker and helper working in unison handling the stack-valve, the primary and secondary blast valves, and turnng on the oil and steam at the "oil table." The oil and steam for heating are admitted through a specially arranged burner shown in one of the illustrations. Separate coils of pipe encircle the generator, one being for oil, and the other for steam, that for



The Apparatus for Generating Oil-Gas.
The illustration shows the arrangement of the primary and secondary generators connecting at the bottom with a throat piece large enough not to constrict the passage for gas; shows the wash-box, which acts also as a hydraulic seal; and shows two ordinary steel scrubbers provided with wooden trays. Ample scrubbing of oil-gas is important.



Oil Burner.



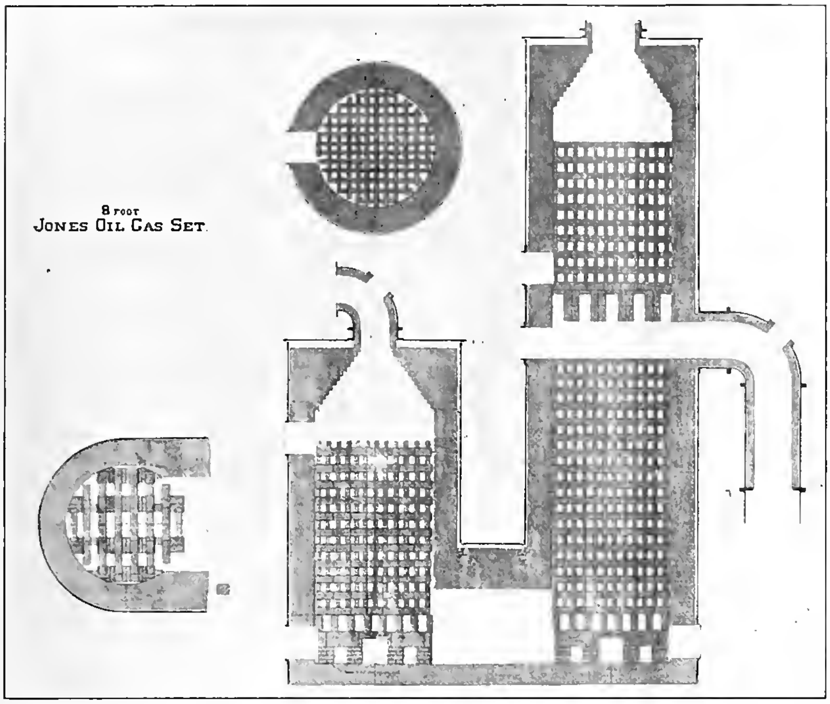
Showing a Vertical Section of the Generators with Their Linings.
Note that the elbows for the admission of air and the outlet of gas are lined with fire brick to protect them from excesive heat.

the oil always being at a lower level than the steam coil. This is a precaution to avoid a possible leakage of oil downward into the burners when the apparatus is not in use. Experience has proven that the straight pipe burner with open end gives better results in large sets than any other kind of burner. Much care, however, has been devoted to the selection of an injector, which will force the oil through the burner into the generator, using steam in the most economical manner. This injector is made of brass, carefully finished, and the oil and steam openings are nicely centered. The straight pipe burner is connected to the shell of the generator through a flange, and on the ouside end of the burner is placed a Y fitting. The injector is attached to this Y fitting, connecting it with the steam and oil pipes. This arrangement does not interfere with the workings of the injector, and has the advantage of leaving a straight way for cleaning the burner with a small rod through the plugged end, C, without disturbing the rest of the burner meahanism.

A regulation service cock is placed on the oil inlet and a standard globe valve, B, on the steam inlet to insure good regulation at the burner. These controlling valves require nice adjustment for the exact proportion of oil and steam, so that when once set the amount of oil and steam used for heating and making is controlled from the oil table.

A glance at the illustration of the oil table shows an oil table for the heating oil and one for the oil used for making gas. Gauges are provided for showing the steam pressure at the boiler, and the oil pressure at the outlet of the oil heater. In addition to this there are six nozzle gauges used in connection with each set. Three are for steam, and three for oil. These gauges are connected to the oil and steam pipe between their respective throttle valves and the machine, so that these gauges practically become steam and oil meters for the guidance of the gas-maker.

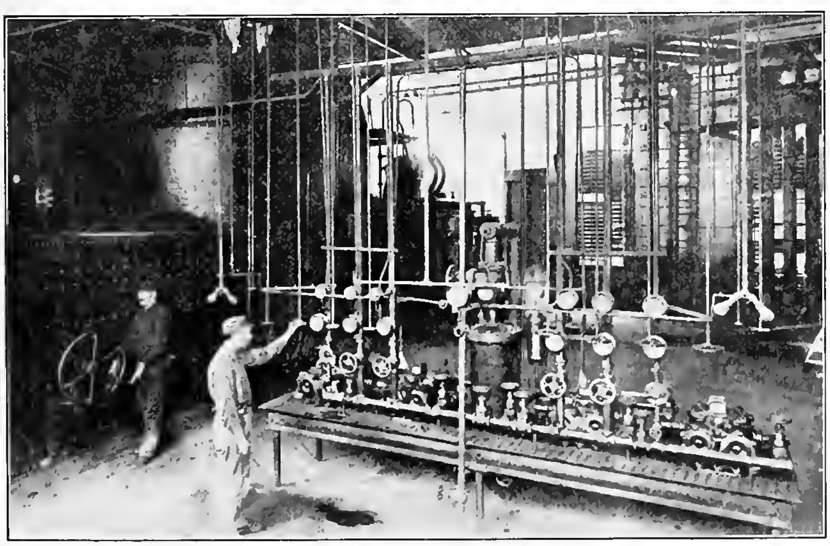
The oil table is also provided with thermometers, a jet photometer, and a test light. The oil is heated to about 150 degrees F. in a tubular oil heater of well-known design. There are nine burners for heating at the top of the primary generator. Assume that



The Arrangement of Checker Brick in the Generators.

the machine has been making gas and a blast is about to begin. The stack valve has been opened and the air is turned on at the blast valve. No oil is admitted to the machine during the first three minutes of the blast, and the steam on the burners is turned on to a sufficient pressure to keep them clean and protect them against overheating. The blast pressure inside of the primary generator is nine inches. At the end of the third minute oil is turned into the primary generator at a pressure of eight pounds inside of the machine, while the steam pressure is retained at thirty-five pounds, and the blast pressure is reduced to seven inches also within the machine.

The duration of the blast in the large machines is twelve minutes; three minutes without and nine minutes with oil.



The Operating Table Between Two 16-Feet Sets, Showing the Convenience and Simplicity of Operation.

At the end of the heat the blast valve is closed, and quick-opening valve at the outlet of the first scrubber is opened by means of a winch attached to the generator and by a wire rope running over pulleys to the valve stem. This valve is opened during runs and closed during heats, for the purpose of isolating the set from the rest of the works during the heating process and to permit the use of high blast pressure without the use of high blast pressure without breaking the seal in the wash-box, thus sending oil produced gas through the wash-box and scrubbers. As the man on the floor turns off the blast, opens the scrubber valve, and closes the stack valve, the gas-maker does not shut off the heating oil. He first turns on the oil and steam to the gas-making burners, which are separate and distinct from the heating burners. Then he shuts off the oil and steam from the heating burners so that there is no interruption in the making of gas. The heating oil serves for this purpose during the moment necessary for changing the valves. The temperature of the primary and secondary generators is observed by means of sight cocks, the gas-maker becoming very skillful in detecting changes of color in the checker brick and turning on secondary air when the outgoing stack gas has the appearance of containing combustible gas.

In this connection the personal factor represented by the skill of the gas-maker enters more largely into the equation of good results than in either coal- or water-gas making. For making gas the oil and steam are first turned into the top of the primary. The oil is decomposed by passing downward through the checker brick in the primary generator, thence through the connecting throat piece and up into the secondary generator. Should the gas thus made be permitted to traverse the entire length of the secondary generator to the top, the illuminants would be partly decomposed by breaking down into marsh gas, hydrogen, and lampblack. To prevent this overheating and to protect the gas the outlet of the machine is placed at or near the middle of the secondary generator. Above this point there is a large amount of heat stored in checker brick placed upon a number of arches, sprung across the generator. These arches are durable, because there is no direct combustion of oil in proximity to them. To make use of the heat in the top of the secondary generator coils of steam and oil pipes are

connected with eighteen burners in the corbel work at the top of the secondary. Fifteen of these burners are used for making gas, while three are steam pipes for purging. The gas thus made passes downward and through the side outlet into the wash-box. It will thus be seen that gas is made in two directions, leaving the machine through a common outlet. The reasons for this are obvious.

The accompanying table shows the progress of the blast on the sixteen-foot set at Generator No. 2 Jones, Monday July 26, 1909:

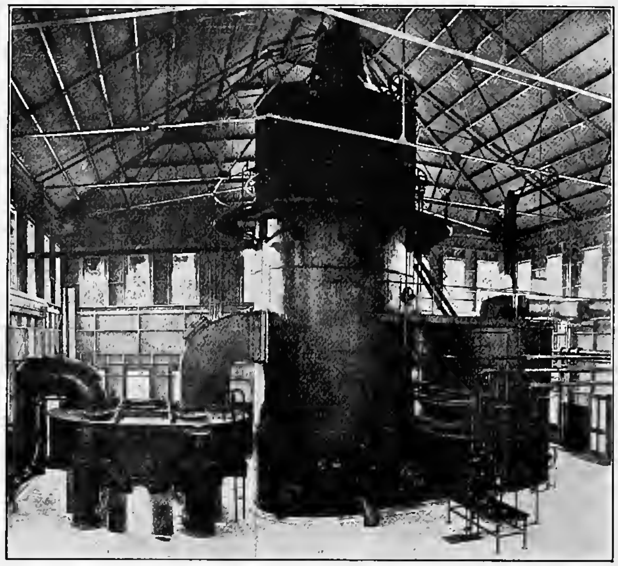
PROGRESS OF BLAST.

Minute	Oil temp., Fahr.	Oil pressure to heat, lbs.	Steam pressure to heat, lbs.	Oil to heat, gallons	Blast pressure, inches
1st			35	blow	9
2d			35	blow	9
3d			35	blow	9
				3.25	7
4th	150°	8	35		
				3.25	7
				3.50	
5th	150°	8	35		
				3.50	
				3.25	7
6th	150°	8	35		
				3.25	7
				3.50	
7th	150°	8	35		
				3.50	
				3.25	7
8th	150°	8	35		
				3.25	7
				8.50	
9th	150°	8	35		
				3.50	
				3.25	7
10th	150°	8	35		
				3.25	7
				3.25	7
11th	150°	8	35		
				3.25	7
				3.25	7
12th	150°	8	35		
				3.25	7
				60.00	

Sometimes during the process of heating, it is difficult so to regulate the temperature in the primary and secondary generators, even if the checker brick in both generators are in equally good condition for breaking up the oil. If the gas were taken off at the top of the secondary it would be impossible so to regulate the heat that no oil would be wasted, no gas overheated, or the yield of gas the minute not reduced. By adopting the side outlet all heat is conserved. If the top of the secondary be overheated more oil is used in that part of the machine, and if the primary be at too low a temperature less oil is used in the primary. In this way all heat is used for gas making and practically one is wasted. At the same time a uniform quality of gas is maintained.

One of the best indicators of the quality of gas being made is the condition of the overflow water from the wash-box and from the first scrubber. The presence of tar in the wash-box seal shows that the heat is too low, and lampblack in the overflow from the first scrubber shows that the heat is too high.

The table following shows the amount of oil used in gallons, in different parts of the set, together with the steam and oil pressures, all pressures being on the inner side of the throttle valves and within the machine. These figures were taken from the run after the foregoing heat. The duration of the run was ten minutes. Oil is admitted to the top of the primary, beginning with twenty-six gallons a minute and reduced to nine gallons during the eighth minute. Oil



A 16-Foot Oil-Gas Set with a Capacity of 150,000 Cubic Feet an Hour.

This is called a 3,000,000-foot set; it will produce that amount of gas every day in the year and can be forced to produce 4,000,000 feet. Eight such sets are in operation in San Francisco and Oakland.

is admitted to the top of the secondary, beginning with thirty-nine gallons during the first and ending with twelve gallons during the eighth minute. The steam pressure remains constant during eight minutes of the run. At the end of the eighth minute the oil is shut off from the primary and secondary; and the steam pressure on the primary and secondary is raised to 110 pounds, and is allowed to remain at this pressure for the last two minutes of the run for the purpose of purging the machine. For purging the machine during the last two minutes of the run three special open steam pipes are used at the top of the secondary. Steam is maintained on the burners at the top of the primary and secondary. A one-inch steam pipe admits steam to the bottom of the primary directly opposite the throat piece; this is also for the purpose of clearing the machine.

MAKE OF GAS, JULY 26, 1909.

Minute	Oil temperature, Fahr.	Oil primary, gals. to make	Oil secondary, gals. to make	Oil pressure primary, lbs.	Steam pressure primary, lbs.	Oil pressure sec., lbs.	Steam pressure, sec., lbs.	Boiler steam pressure, lbs.
1st	150	26	39	21	25	27	25	110
2d	150	26	39	21	25	27	35	110
3d	150	18	26	19	25	24	35	110
4th	150	18	26	19	25	24	35	110
5th	145	18	26	19	25	24	35	110
6th	145	17	26	19	25	24	35	110
7th	145	17	26	19	25	24	35	110
8th	145	9	12	19	25	24	35	110
9th	140	purge	purge		110		110	110
10th	140	purge	purge		110		110	110

Following are two analyses of gases taken at the stack valve at the middle of the heating period:

JONES SET No. 2.

Composition.	Percentages.
Carbonic acid	13.1
Oxygen	1.9
Nitrogen	85.0

JONES SET No. 1.

Carbonic acid	15.3
Oxygen	0.2
Nitrogen	84.5

These analyses are frequently taken to determine the ratio of air to heating oil.

According to experiments at Munich in 1880 (Stillman's Engineering Chemistry) 6 per cent of carbonic acid indicates three times the theoretical amount of air required; 9 per cent of carbonic acid indicates two times the theoretical amount of air required; 17 per cent of carbonic acid indicates one time the theoretical amount of air required.

The following table gives the make of gas a minute for a series of five runs. These tests were of necessity on different days so that the gas could be carefully measured in a relief holder isolated for the purpose and careful corrections for temperature be made to avoid error in measurement. The amount of oil used for heating and making and also the total oil used by the thousand feet of gas are given in this table. The make of gas a minute during a ten-minute run is a good indication of the application of the heat contained in the checker brick in the making of gas, and is an index to the proper length of run.

TEST RUNS ON NO. 2 JONES SET.

Min.	July 9	July 10	July 10	July 12	July 12	Average
1st	7,080	6,664	5,206	8,538	7,497	6,997
2d	6,247	7,705	6,872	6,664	9,371	7,372
3d	6,039	7,080	7,082	8,333	7,497	7,206
4th	5,831	6,664	6,247	8,225	7,393	6,872
5th	5,623	6,248	6,248	6,248	6,664	6,206
6th	5,623	6,248	6,247	6,351	5,831	6,060
7th	5,415	6,664	6,248	6,559	6,768	6,331
8th	4,790	2,915	4,165	3,748	3,540	3,832
9th	2,707	2,290	2,082	1,978	2,291	2,270
10th	2,082	1,042	2,082	1,874	833	1,583
Totals ..	51,437	53,520	52,479	58,515	57,685	54,729
Oil for	Gals.	Gals.	Gals.	Gals.	Gals.	Gals.
Heat	70	70	70	70	70	70
Make	370	373	370	370	400	377
Total	440	443	440	440	470	447
1,000 cu. ft.	8.55	8.28	8.38	7.53	8.13	8.17

Following is a table giving the analyses of the gas made during a run July 19, 1909, on Jones Set No. 2. Samples of gas were taken from the wash-box at the end of the second, fifth and seventh minutes, and analyzed:

Composition.	End of 2d min.	End of 5th min.	End of 7th min.
Carbonic acid gas........	1.6	0.8	0.4
Illuminants	3.4	6.6	9.0
Oxygen	0.2	0.2	0.0
Carbonic oxide	9.4	8.0	6.6
Hydrogen	53.2	50.6	44.8
Marsh gas	28.5	30.9	35.0
Nitrogen	3.7	2.9	4.2
B. T. U. the cu. ft........	589.0	665.0	732.0
Specific gravity	.382	.391	.423

The results of a typical run at the Potrero Station, San Francisco, June 4, 1909, giving the amount of gas made, oil used, and an analysis of the gas taken at the outlet of the wash-box during the first minute, when all the gas was made in the primary generator, and during the second, fifth, seventh, and tenth minutes, are shown in the following table, which gives the analyses of samples taken at the outlet of the wash-box of the No. 3 Jones Set.

RESULTS OF TYPICAL RUN.

Composition.	1st Min.	2d Min.	5th Min.	7th Min.	10th Min.
Car. acid........	1.8	1.3	0.0	0.0	0.0
Illuminants	8.6	2.1	5.0	5.8	7.8
Oxygen	Tr.	Tr.	Tr.	Tr.	Tr.
Car. oxide	5.6	20.2	9.4	8.2	14.6
Hydrogen	31.7	44.1	46.6	44.9	47.4
Marsh gas	43.4	26.7	35.7	37.3	25.9
Nitrogen	8.9	5.6	3.3	3.8	4.3
B. T. U.........	765.0	549.0	675.0	698.0	747.0
Specific gravity.	.614	.469	.402	.411	.435

Minute	Cubic Feet
1st	5,625
2d	5,833
3d	6,041
4th	5,625
5th	5,416
6th	5,000
7th	4,373
8th	4,166
9th	3,125
10th	833
Total.........	46,041

Oil 320 gallons to make, 60 gals. to heat; 380 gallons total.

8.25 gallons for each 1,000 cubic feet.

7½ minute primary oil off.

8th minute secondary oil off.

The percentage of carbonic oxide in these analyses would lead to the conclusion that the carbonic oxide is not formed by contact of steam and the carbon remaining in the generators after a heat.

It will be noticed that the gas made in the primary generator at the beginning of the run contains 5.6 per cent of carbonic oxide, while during the second minute it increases to 20.2 per cent and then drops to less than half that amount during the fifth and seventh minutes, rising again to 14.6 per cent during the tenth minute. The carbonic oxide is undoubtedly produced by the dissociation of steam in contact with incandescent particles of lampblack, which have been thrown down by the breaking down of hydrocarbons.

A fact now well understood is that the oxygen of steam will not unite with carbon in combination with hydrogen, so that neither carbonic acid nor carbonic oxide is generated directly from the hydrocarbons of the oil in contact with steam. First it is necessary to convert the oil into gas or hydrocarbon vapor and then break down the hydrocarbons into lampblack and hydrogen. This lampblack, becoming incandescent, will unite with oxygen of steam. The high percentage of nitrogen in the primary gas is probably due to the presence of a small amount of products of combustion remaining in the primary generator after the heat. The nitrogen diminishes to the fifth minute and then increases to 4.3 per cent during the tenth minute.

California petroleum contains more than 1 per cent of nitrogen; usually 1.1 per cent. This is twice the amount of nitrogen contained in the petroleum of Pennsylvania and West Virginia. In distilling California petroleum the third fraction, taken off between 200° and 250° C., has a strong odor of ammonia. This ammonia is destroyed in the gas generators at higher temperatures, and appears in the gas as nitrogen and hydrogen.

Further to determine the part played by the steam admitted with the oil three runs were made on a sixteen-foot set, first in the ordinary way, second with oil injected under its own pressure without steam, and third by steam without the use of any oil. In each case the test was made after the generator had been heated ready to make gas. And these are the results:

Composition	Ordinary run	All oil	All steam
Carbonic acid	0.4	0.4	43.8
Illuminants	5.2	6.2	0.0
Oxygen	0.1	0.1	0.2
Carbonic oxide	7.0	5.3	10.6
Hydrogen	46.6	47.9	5.0
Marsh gas	30.6	36.7	0.0
Nitrogen	5.1	3.4	40.4
Specific gravity	.404	.388	1.168
B. T. U. a cu. ft..........	668.302	700.746	53.55

Ordinary run—Same gauge pressure as combined oil and steam runs; 17-in. pressure inside machine, 47 gals. a minute.

All oil run—18 lbs. to 19 lbs. oil pressure on primary, 25 lbs. to 27 lbs. oil pressure on secondary; 21-in. pressure inside machine; 51 gals. a minute.

All steam run—25 lbs. pressure on heat burners; 26 lbs. pressure on primary make burners; 32 lbs. pressure on secondary make burners; 10-in. to 11-in. pressure inside machine.

The run made with all steam can not be directly compared with the two other runs, as very little gas was produced; barely enough to enable the taking off of a sample at the wash-box. The generator at this period was at the same temperature as during ordinary runs. That is, it was at a temperature high enough to decompose steam in the presence of incandescent carbon, and only 10.6 per cent of carbonic oxide was produced. Had there been much carbon deposited on the checker brick this generator would have been in ideal condition for the manufacture of "blue" water-gas.

As to the California petroleum from which this gas is made, the crude petroleum from 12 degrees to 17 degrees B. is best adapted to the purpose of making gas. This oil has an asphaltum base, as has most of the petroleum produced in California. This makes it in a measure unattractive to oil refiners. The California crude petroleum used during the following experiments was 15.8 degrees B. at 60 degrees F. Distillation began at 85 degrees C.

	Temperatures	Percentages	Color of fraction
No. 1	Below 150° C.	5.0*	yellowish
No. 2	150° — 200° C.	4.0	yellow
No. 3	200° — 250° C.	27.5	lemon H_1S and NH_2
No. 4	250° — 300° C.	14.0	lemon
No. 5	Above 300° C.	39.5	red
No. 6	Coke	8.0	black
	Loss	2.0	
	Total	100.0	*2¼% water

Flash point, 257° F.

Fire test, 293° F.

After the 300° fraction comes off the temperature rises immediately to above 380° C.

The ultimate analysis of oil taken from this same field is:

Carbon	85.	per cent
Nitrogen	1.	per cent
Sulphur	.8	per cent
Oxygen	1.0	per cent
Hydrogen	12.2	per cent
Total	100.0	by weight

The exact amount of sulphur in the oil used for these experiments was 0.93 per cent.

Oil containing sulphur in quantity less than 1 per cent will produce gas which may be satisfactorily purified by ordinary oxide of iron. Should the percentage of sulphur exceed 1 per cent, purification becomes difficult, unless there is a large purifying capacity provided for it. Crude oils in California in some instances contain as much as 4 per cent of sulphur. It is better not to purchase oils containing so much sulphur as it is necessary to provide elaborate and expensive means for purifying the gas. Fortunately the most available crude oils, produced in greatest abundance and best adapted to oil-gas making, have a small percentage of sulphur. After these crude oils are distilled and the distillates are sold for gas manufacture the distillate contains all of the sulphur of the crude oil condensed into the lesser quantity of distillate.

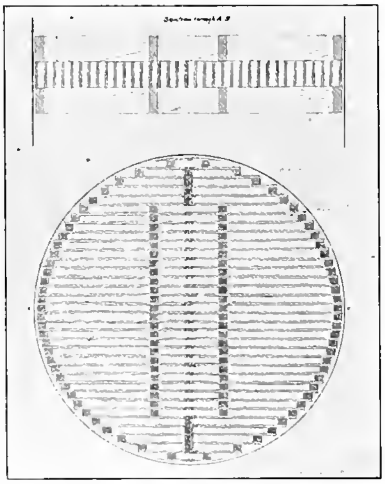
It is the opinion of the writer that a crude petroleum from 14 degrees to 16 degrees B. is the oil which gives the best results in oil-gas making. In other words, the more pounds in weight to the gallon of oil the greater will be the production of gas, and there will be less waste of oil. This is diametrically opposed to good water-gas practice, but the conclusion has been reached after the use in practice and experimentally of crude oils from 8 degrees B. to 37 degrees B. and distillates from 20 degrees B. to 42 degrees B.

The wash-box serves a double purpose as a hydraulic seal and as a piece of apparatus in which nearly all of the lampblack is separated from the gas and held in suspension in the water. The early forms of wash-boxes were comparatively of small dimensions and were filled with baffle plates and partitions, forming excellent lodging places for lampblack, so that the cleaning of the wash-boxes was an important part of the gas-maker's daily work. In the development of a self-cleaning wash-box, to take care of the amount of lampblack made by a sixteen-foot set, it became necessary to depart from the square or circular form and adopt an oval shape, having a superficial area of 265 square feet, also to depart from the usual custom of connecting the generator to the wash-box and the wash-box to the scrubbers with pipe of the same or even smaller diameter than the trunk mains in the gas works. Allowance is made for the expanded condition of the hot gas leaving the generator. In what is known as a twenty-four-inch gas works the inlet and outlet pipes to the wash-box are forty-eight inches in diameter, while the diameter of the dip pipe in the wash-box flares to sixty-eight inches. This removes one of the chief causes of back pressure and enables the hot gas easily to get away from the machine.

In the new form of wash-box there are no partitions or diaphragms, and the space within the box is clear. The gas enters through a dip pipe at one end, and passes out through an outlet pipe from the top of the wash-box at the other end. Two large overflows on the side of the wash-box carry away the lampblack. The self-cleaning principle of this wash-box is in the constant agitation of the water in the box. This agitation is produced by dividing the main water supply into a number of one-inch pipes, twelve in all, extending to within three inches of the bottom of the wash-box. The water is thus forced downward to the bottom of the box, and it rises to the overflow. The lampblack is washed out of the gas by this turbulent water, and is carried out of the box before it has an opportunity to settle. The average temperature of the water entering the wash-box is 61 degrees F., and the average temperature of the water leaving the wash-box is 129 degrees F. The temperature of the gas leaving the wash-box is 142 degrees F., and the amount of water used in the wash-box is forty-six gallons for each thousand cubic feet of gas. The lampblack and water pass from the wash-box through open drains to the lampblack separator.

Thorough scrubbing of oil-gas is all important. It has been proven conclusively that it is better to treat oil-gas directly with a large quantity of water than to use the methods of condensing and scrubbing as applied to coal-gas, where valuable by-products must be removed. Oil-gas requires more water for scrubbing than any other kind of gas, on account of the finely divided particles of lampblack held in

suspension in the gas. These must be removed, as they would tend to destroy the purifying material. Should the lampblack pass through the purifiers it would cause endless trouble by stoppages. One uniform kind of scrubber and one method of filling it have been adopted. The old-style cylinder filled with trays through the top is the best to be had, but the filling should be carefully done. The trays are made of one-inch by six-inch pine lumber surfaced on four sides and nailed together in sections, with spacing pieces one inch thick also made of surfaced lumber. These trays are made in sections small enough to go through a door on the top of the scrubber. Each alternate layer of trays is placed at right angles to the one immediately under it, and the entire shell is filled without voids of any kind. As these trays are made somewhat smaller than the inside diameter of the steel shell, in order to provide for easily getting the trays in and out and for the swelling of the wood, it is essential that the space between the trays and the shell shall be caulked with excelsior, so that the gas can not pass round the trays instead of through them, or the water flow down the inside of the shell. In this way the gas is compelled to pass upward through the trays, meeting smooth wet surfaces; and the water



Trays for 6-Foot Scrubbers.

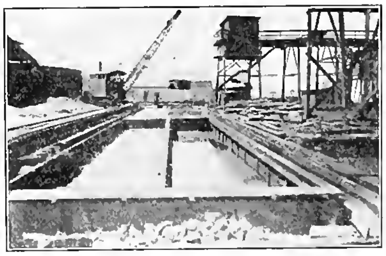
passes evenly downward through the trays, thus the maximum efficiency is obtained by the use of the smallest amount of water.

A plan of a scrubber tray and the arrangement of the trays in the scrubber are shown in the accompanying illustration. In the larger works there are three scrubbers twelve feet seven inches in diameter by forty feet high, and the water is supplied to them through ten sprays passing through the top head. With each sixteen-foot apparatus the amount of water used is approximately fifteen gallons for each thousand cubic feet of gas for each scrubber, or forty-five gallons the thousand cubic feet for the complete scrubbing of the gas. Salt water is used in the wash-box and in all the scrubbers. It gives satisfactory results, having no deteriorating effect upon the gas or upon the scrubbing apparatus. Salt water has the further advantage, where gas works are located on tide water, of being available in abundance at small cost for pumping, and it can be wasted after it has been used. In small plants, where water is scarce or expensive, it becomes necessary to be more saving in the use of water and in some cases to cool the water and use it over again.

The overflow water containing lampblack flows from the wash-box through open, exposed drains into the lampblack separator. In nearly all oil-gas works the overflow water containing tar from the scrubbers flows into the same separator. The amount of tar is so inconsiderable that it is seldom recovered for sale, but when the tar is mixed with lampblack it adds somewhat to the fuel value of the lampblack and acts as a binder in briquetting.

Separators of small dimensions and containing many partitions have been superseded by those of much larger dimensions with fewer partitions. Experience with the separating of lampblack from water has developed the fact that the greater the area of the separator, and consequent slower speed of flow of water, the more thoroughly is the lampblack separated from the water.

The lampblack-and-water first empties into a separator provided with a constantly moving skimmer, consisting of pieces of 1 x 3 oak fastened to sprocket chains. The light, fluffy lampblack, rising to the surface of the water, is skimmed off by these scraping pieces and taken through a trough to a height of about twenty-five feet, and emptied into a settling tank, the walls of which are made of dry lampblack in the form of the crater of a volcano. After this skimming process the water flows into a separator, an illustration of which is here shown.



Where the Lampblack Is Separated from the Water.

This picture is of a separator recently installed. This separator is capable of separating lampblack from water used in the manufacture of 12,000,000 feet of gas a day. In this separator there is a single partition running longitudinally. The partition is provided with a skimmer extending below the surface of the water. The separator is made in two sections to enable the alternate cleaning and use of the sections. The water containing lampblack flows into one of the large pits, and the separation is accomplished by the settling of the lampblack particles through the water. This process is of necessity slow, because the specific gravity of the lampblack is so nearly that of water. The water passes under the skimmer and over the partitions into the next pit, where further settling takes place. Out of this pit the clarified water passes through an open flume and is wasted. When the two pits are filled with lampblack the water gates are opened into the next pair of pits, and the water is shut

off from the pits filled with lampblack. The removal of the lampblack is then performed by means of a locomotive crane with a clam-shell bucket. The water-soaked lampblack thus removed is deposited in a pile and allowed to drain. After it has drained until there is about 30 per cent of water remaining in it, it may be used as boiler fuel. This was the only use to which lampblack was put in the early days of oil-gas making. Attempts were afterward made to make lampblack briquettes for domestic use. This proved difficult on account of the large amount of water contained in what seemed to be comparatively dry lampblack. It was found that the only simple and practical method of briquetting was by the use of a plunger operated by a crank shaft to force the lampblack into an open cylindrical mold, thus forming an endless briquette, after the manner of a sausage machine. These briquettes would break by their own weight in lengths that were multiples of the length of a stroke. That is, if the stroke of the machine were 1½ inch, the briquettes would break off in lengths of 3, 4½, or 6 inches. This method was found to be slow and expensive. So a vertical press was invented which had four plungers arranged on one shaft. The lampblack was fed through a trough into four molds and pressed by the plungers into and through these molds, breaking off into pieces in the same manner as described of the single horizontal press. This vertical press produced fifty tons of briquettes in twenty-four hours. The briquettes were three inches in diameter, weighed 5.4 ounces the linear inch, or 82½ pounds the cubic foot. They were smooth on the outside and possessed cohesion enough to permit of ordinary handling. The only binder used in the making of these briquettes was the normal amount of tar flowing from the scrubbers into the lampblack separator. Apparently the briquettes were dry when made, but they still contained a considerable quantity of water.

Here is an analysis of a briquette after it had been stored for one year in a dry place:

Moisture	8.5 per cent
Volatile matter	10.8 per cent
Fixed carbon	79.9 per cent
Ash	0.8 per cent
Total	100.0 per cent

These briquettes are an ideal fuel, particularly for use in open grates. Owing to the small percentage of ash, the briquettes when once ignited remain at a glowing heat until they are entirely consumed. The only objection to the use of them is the strong odor of naphthalene which they possess, and which does not entirely disappear after storage for a long time.

In order to avoid the inconvenience of dealing in by-products, it was decided to make the experiment of using lampblack briquettes as a substitute for anthracite coal in water-gas generators. In a station contiguous to the Potrero plant in San Francisco there were six sets of double, superheated, Lowe water-gas apparatus, with a rated capacity of 1,000,000 cubic feet each. Briquettes were used in these sets with some success, but the capacity of the sets was reduced 50 per cent by using lampblack; that is to say, no more than 500,000 cubic feet of gas could be made in a day with a set rated at 1,000,000 cubic feet. But the making of gas in this way had decided advantages; there was an entire absence of clinker, and very little time was required to clean the fires. Contrary to expectations, the air pressure required to blast through lampblack was extremely low, never exceeding nine inches. The average amount of lampblack used the thousand cubic feet of gas covering a period of six months was 39.86 pounds, and the oil used for enriching was 6.8 gallons a thousand. This oil was the ordinary 14° to 16° crude oil with asphaltum base. The candlepower ranged from 28 to 33 candles. At that time the gas supplied to San Francisco was 23 candlepower. The oil-gas, which was made in the large generators, was 19 candlepower. The candlepower of the oil-gas was raised by mixing about 24 per cent of the high candlepower lampblack water-gas with it.

Here is a typical analysis of the lamyblack water-gas:

Composition	Percentage
Heavy hydrocarbons	16.5
Marsh gas	32.8
Hydrogen	24.6
Carbonic oxide	13.7
Carbonic acid gas	6.2
Oxygen	0.2
Residual nitrogen	6.0
Total	100.0
Specific gravity	.647
Net B. T. U. the cu. ft.	814.
Candlepower	28.5

A lampblack fire is apt to flue during the blast, and it requires some care to keep the fuel bed in condition, as shown by the amount of carbonic acid in the gas produced.

In using the lampblack the ordinary round grate bars are placed half an inch apart. Great care is necessary not to overheat the superheater and thus make lampblack in the water-gas apparatus. During the heavy demand for gas during the winter of 1908-9 the use of lampblack exceeded the capacity of the single briquetting press. It became necessary to use lumps of lampblack dug from the side of a pile of dry material. These lumps were of about the same size as the coarse anthracite coal ordinarily used, and were broken away from the pile with pick-axes. It was found that the lumps held their shape fairly well in the generator, and gave fully as good results as briquettes. So lump lampblack was substituted for briquettes in all the generators, thus saving the cost of briquetting and considerably reducing the cost of lampblack water-gas.

Following is a recent analysis of the lampblack used in the generators:

Volatile matter, including moisture	34.15 per cent
Fixed carbon	65.80 per cent
Ash	0.05 per cent
Total	100.00 per cent

The first lampblack water-gas was made July 14, 1906. This gas has been made continuously, without the use of other fuel in the generators, since May 5, 1907.

The improvements in oil-gas manufacture described in this paper have made it possible to regulate the amount of lampblack produced so that a combination of oil-gas and a lampblack water-gas plant will produce only enough lampblack for boiler fuel and generator fuel, with no product remaining for sale, excepting gas. The amount of lampblack now produced in the largest oil-gas sets is twenty pounds the thousand cubic feet of gas.

For the purpose of showing the average composition of oil-gas, lampblack water-gas, and the mixed gas now made and distributed in San Francisco, the accompanying series of ten analyses of each are given. These analyses were taken at random during each of the dates from June 11th to June 22d, inclusive, so the average of these is a good criterion of the composition of the gas.

ANALYSES AND AVERAGES OF TEN SAMPLES OF CRUDE-OIL-GAS

June	CO_2	C_nH_{2n}	O_2	CO	H_2	CH_4	N_2	C. P.	B.T.U.	Sp. gr.
11th	2.5	7.1	0.2	9.2	40.5	33.8	6.7	18.4	675.	.479
12th	2.5	7.0	0.2	9.3	37.8	35.8	7.4	22.2	686.	.495
14th	2.4	8.0	0.2	9.4	40.0	33.3	6.7	21.2	687.	.485
15th	2.8	6.2	Tr.	9.4	39.0	35.4	7.2	18.5	670.	.487
16th	2.2	6.8	0.2	8.8	40.1	35.5	6.4	20.8	685.	.474
17th	2.4	7.0	0.2	8.4	42.8	34.2	5.0	18.8	683.	.456
18th	2.4	7.0	0.2	9.4	38.7	35.1	7.2	18.7	681.	.489
19th	3.0	7.2	Tr.	9.8	39.1	34.7	6.2	19.7	684.	.490
21st	3.0	6.8	0.4	9.4	40.2	33.5	6.7	18.4	665.	.481
22d	3.0	7.0	Tr.	9.0	39.6	35.1	6.3	20.2	683.	.484
Av.	2.62	7.01	0.16	9.21	39.78	34.64	6.58	19.69	679.9	.482

ANALYSES AND AVERAGES OF TEN SAMPLES OF CARBURETTED WATER-GAS

June	CO_2	C_nH_{2n}	O_2	CO	H_2	CH_4	N_2	C. P.	B.T.U.	Sp. gr
11th	5.6	17.0	0.2	14.0	26.0	31.6	5.6	32.5	816.	.636
12th	5.6	16.8	0.2	13.4	23.8	34.7	5.5	32.2	836.	.643
14th	5.4	17.0	Tr.	13.6	27.0	32.0	5.0	33.1	822.	.624
15th	6.0	17.0	Tr.	13.0	25.6	33.6	4.8	30.5	833.	.633
16th	5.6	16.2	Tr.	13.6	24.4	33.4	6.8	29.1	812.	.643
17th	5.7	16.3	Tr.	13.2	25.2	33.5	6.1	29.5	817.	.635
18th	6.0	16.0	Tr.	13.0	25.3	33.6	6.1	28.3	812.	.636
19th	5.8	16.0	Tr.	14.2	24.9	32.0	7.1	28.8	797.	.645
21st	5.5	15.5	0.2	13.8	25.3	32.5	7.2	30.3	793.	.638
22d	6.0	16.0	Tr.	14.0	23.5	34.1	6.4	30.4	814.	.650
Av.	5.72	16.38	0.06	12.58	25.10	33.10	6.06	30.47	816.2	.638

ANALYSES AND AVERAGES OF TEN SAMPLES OF MIXED CRUDE-OIL GAS AND CARBURETTED WATER-GAS

June	CO_2	C_nH_{2n}	O_2	CO	H_2	CH_4	N_2	C. P.	B.T.U.	Sp. gr.
11th	3.4	9.2	0.4	11.0	37.2	32.9	5.9	21.8	703.	.518
12th	3.5	9.7	0.4	9.8	36.6	33.2	6.8	22.9	710.	.522
14th	3.4	10.2	0.4	10.0	36.3	33.6	6.1	22.9	724.	.523
15th	4.0	10.0	0.4	10.6	35.8	32.5	6.7	21.4	708.	.535
16th	3.5	9.3	0.4	10.2	38.3	31.9	6.4	21.6	696.	.512
17th	3.4	9.6	0.2	10.0	36.7	34.6	5.5	20.9	724.	.515
18th	3.6	10.0	0.4	10.0	37.2	32.3	6.5	21.5	709.	.521
19th	4.0	9.6	0.2	10.6	34.5	34.0	7.1	22.1	712.	.540
21st	3.8	9.7	0.2	10.0	35.6	33.7	7.0	21.7	712.	.531
22d	3.7	9.7	0.4	10.2	37.2	32.9	5.9	22.0	710.	.519
Av.	3.63	9.70	0. 34	10.24	36.54	33.16	6.39	21.88	710.7	.5236

The amount of gas made and the percentage of oil-gas and of water-gas involved in the immediately preceding analyses are given in the following table:

June	Oil-gas made M	Water-gas made M	Per cent oil-gas	Per cent water-gas
11th	6,921	2,095	77	23
12th	7,094	2,089	77	23
14th	6,664	2,090	77	23
15th	6,522	2,090	76	24
16th	7,054	1,975	78	22
17th	5,976	2,102	74	26
18th	6,072	2,102	74	26
19th	6,718	2,077	77	23
21st	6,742	2,097	76	24
22d	5,869	2,060	74	26
Average	6,563	2,077	76	24

The early days of oil-gas were filled with doubts as to whether it could ever take the place of coal-gas or water-gas. Doubters prophesied that the gas would not be fixed and that it would be impossible to maintain uniformity in candlepower. These doubts and fears have all been allayed. Oil-gas as now made in California has the same stability as well-made coal-gas, with the further advantages that any desired candlepower may be maintained and that naphthalene stoppages can be practically controlled from the station.

An examination of the coroner's records shows that nearly all of the deaths from gas asphyxiation were suicides. This leads to the thought that when it became known that illuminating gas containing much carbonic oxide was a simple and convenient means of suicide gas became popular with suicides. The introduction of oil-gas immediately dropped the percentage of carbonic oxide to less than 7 per cent, and deaths from gas asphyxiation became rare. There followed many unsuccessful attempts at suicide. Persons deliberately turned on the gas in closed rooms, but, after remaining under its influence for several hours, were easily resuscitated. A great many instances of this kind seemed to discourage the use of gas as a means of suicide. The subsequent improvements in oil-gas that increased the percentage of carbonic oxide to 9 per cent and the addition of lampblack water-gas that further increased it to between 10 and 11 per cent have not increased the mortality from gas asphyxiation. This would seem to prove that very few deaths from gas asphyxiation are purely accidental.

The question now naturally arises, In what localities can oil-gas be made a commercial success? This depends primarily on the cost of oil. As oil-gas can be made in large or moderate size machines, with nine gallons of oil or less, the cost of oil the thousand cubic feet may be easily calculated from the cost of oil the barrel delivered in any given place. Next is the item of labor. In California, and particularly in San Francisco, labor is strongly unionized, and the wages of the men employed in gas works are much higher than in other parts of the country. The hours of labor are invariably eight a day, so that it requires three shifts of men to operate any gas-making apparatus. Gas-makers received $110 a month, their helpers $90 a month, and no ordinary laborer is paid less than $2.50 a day for eight hours' work. With these high prices for labor prevailing, it is imperative that the largest units for gas making shall be employed. The large generators herein described have accomplished great saving in the cost of labor in gas making.

During December, 1908, at the Potrero station in San Francisco, the amount of gas made was 267,792,000 cubic feet, and the cost of labor the thousand was as follows:

Generator labor, including gas-makers, helpers, and all men on the floor	$0.00811
Labor handling lampblack by hand	.00585
(This was before the installation of the crane for handling lampblack)	
Estimated cost handling lampblack by crane	.00333
All purification labor	.00491

During June, 1909, the total make of gas was 170,776,000 cubic feet.

Labor in the generator room	.00994
Handling lampblack	.00522
Purification wages	.00624

The miscellaneous labor about the works, including firemen, water tenders, engineers, helpers, other mechanics, and office help, is about the same as in any economically operated water-gas plant where no residuals are handled. The improvements in labor-saving apparatus in oil-gas making have thus kept pace with the increase in wages and the reduction of hours of labor, so that the present system of gas making is most economical, notwithstanding the obstacles presented by local conditions.

The future of oil-gas depends largely upon the price of oil and the practice of economy in the manufacture of gas. The price of oil may be regulated by a gas company owning its own source of supply of oil, and the practice of economy rests in the hands of every conscientious worker in the gas industry.—*American Gas Institute.*

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER VII.

(Continued.)

Shop Methods of Testing.

A very convenient and flexible laboratory testing board is shown diagrammatically in Fig. 96, which can be used for testing single phase watthour meters of voltages from 100 to 500 inclusive, and of any ampere capacity, the load being regulated by switching more or less of the lamps in circuit by means of the single pole switches, L. The indicating wattmeter may be of 5 or 10 ampere capacity, and can be conveniently mounted in a horizontal position on a swinging bracket; the current transformer being of a 5 or 10 to 1 ratio, or if desired, several current transformers of different ratios may be used. For testing 110-volt watthour meters of capacities not greater than the capacity of the indicating wattmeter, the d.p.d.t. switch S″ is thrown in the downward position, thus putting potential on the 100-volt tap of the indicating wattmeter and on the potential winding of the watt hour meter through the variable resistance; at the same time the t.p.d.t. switch S′ is thrown down, thus connecting the

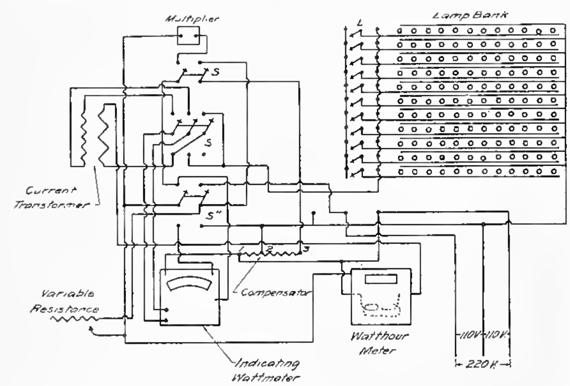


Fig. 96.

indicating wattmeter directly into the circuit. By throwing S′ up, the current transformer is connected into circuit when it is desired to test higher capacity meters. The correct load, as near as possible, is obtained by closing the switches L, and a finer adjustment is accomplished by means of the variable resistance shown in the diagram. This variable resistance is most conveniently made up by wrapping a bare resistance wire on a suitable mandrel and having a sliding contact which will not interrupt the circuit in passing from one turn of the wire to the next. By means of this variable resistance, the tester can hold the load on the wattmeter constant while the test is being made.

For testing 200-volt meters, the switch S″ is thrown in the upward position, and S′ is thrown down or up according to whether the meter in test is below or above the capacity of the indicating wattmeter.

For testing 500-volt meters the switch S is closed, which puts the potential winding of the watt hour meter directly across the 500-volt tap of the compensator, at the same time putting the potential coil of the indicating wattmeter across the 500-volt circuit in series with the multiplier.

In testing meters on loads of low power factors, suitable reactances can be substituted for the ordinary lamp bank (arc lamp reactances can sometimes be conveniently used for this purpose), or the potential windings of the meter may be excited from a different phase of a three-phase system from that which is supplying the load; in this case the power factor will be 50 per cent, and may be either lagging or leading, depending upon which phase is used for exciting the potential winding. In lagging the meter for low power factors, a two-phase system may be used, exciting the potential winding from one phase and furnishing current from the other, in which case the disc should remain stationary with full load current flowing.

In order to determine which phase of a three-phase system to use for exciting the potential windings to get a lagging power factor, and which phase to use in order to get leading power factor, simply connect a small reactance coil in the place of the lamp bank (if such a load is employed), and then connect the potential winding of the meter first to one phase and then to the other. The meter will run slower on the phase giving a lagging power factor.

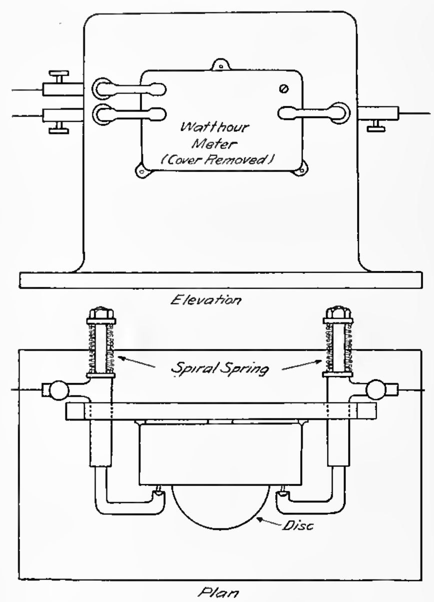


Fig. 97.

Where a great number of watthour meters of the same type are to be tested (such as is the case with large distributing companies in testing new meters), the testing stand shown in Fig. 97 permits of very rapid work, since a meter can be hung in place and connections made within three or four seconds. The stand consists of a wooden base about 2 x 1½ ft., upon which is mounted another vertical 2-in. board of about the same dimensions. Fig. 97 shows the elevation and plan views. Three "L-shaped" terminals are brought out through the vertical board, the spiral springs being used to press the terminals firmly against the binding screws of the meter's connection block.

Another method, employing a connection board essentially the same as shown in Fig. 96, is shown diagrammatically in Fig. 98. Instead of using a lamp bank for loading the watthour meter in test, a "phantom load" transformer, T, is used, the secondary of

which is capable of supplying a heavy current at a very low potential, thereby necessitating only the small resistance coils, L, for regulating the load. This

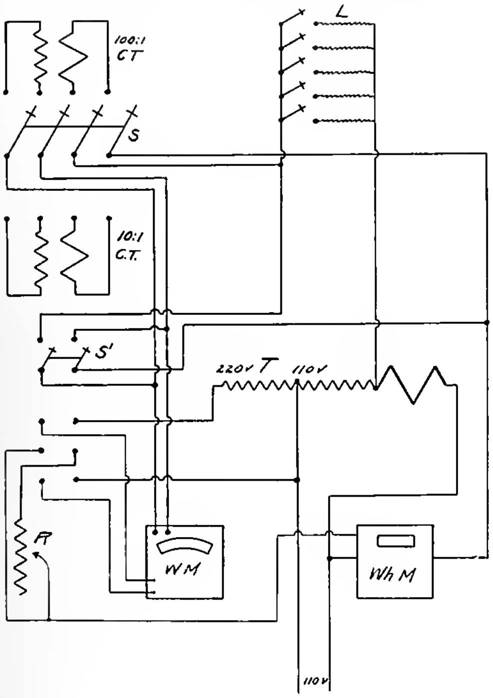


Fig. 98.

method requires only a small amount of power even in the case of large meters, and is therefore very economical.

Testing Polyphase Meters.

In testing polyphase watthour meters, it is usually most convenient to adjust and test them on a single-phase circuit as simple single-phase meters; a polyphase meter so tested will then be correct for polyphase work. The current coils may be connected in series and the potential coils in multiple for testing as a single-phase meter; when tested in this way the constant of the meter should be divided by two, since the current is passing through both elements and is consequently being registered twice. A balanced reading should be taken on both elements as follows:

Potential should be put on both elements and a load put on the current coil of one element, the number of revolutions which the disc makes in a given time being noted; the current coil of this element should then be disconnected and that of the other element connected in the same manner with the same load applied for the same length of time, the revolutions of the disc again being noted. The revolutions of the disc in each instance should be exactly the same, and if any variation is found, the element whose speed is incorrect should be adjusted as described in Chap. III.

A better method of testing polyphase meters is to apply polyphase potential to the potential windings exactly as will be the case when the meter is in service. With such connections, a load is placed on one element and the meter tested as though it were a single phase meter, using the disc constant as stamped on the disc (divided by the ratio of the current transformers times the ratio of the potential transformers). The load should then be taken off of this element and the other loaded, by means of which a "balanced" reading can be obtained, proper adjustments being made if the elements do not balance. The advantage of testing the meter with polyphase potential applied to the potential windings is that the interference of the potential winding of one element with that of the other will be normal, and can be compensated for to great extent in the calibration of the meter.

A three-phase, four-wire meter can be tested exactly the same as a three-phase, three-wire meter by using the two current windings which are wound one on each element, leaving the third current winding open-circuited. The third winding is wound on both elements and when such a meter is tested on single-phase current with both potential coils connected in multiple the meter will run at double speed when this winding is carrying the load.

Polyphase meters should always be calibrated for 50 per cent power factor as well as for unity power factor, since they are almost always used upon circuits which at times operate under low power factor conditions.

Meters Used With Current and Potential Transformers

When watthour meters are used in connection with "current," or "series," transformers, there are two possible sources of error which may ensue; one being due to the angular displacement between the primary and secondary currents of the transformer (this displacement should be exactly 180 degrees), and the other is due to the varying ratio of the transformer at various loads. The first of these two sources of error is negligible except in the case of low power factors, and is largely compensated for by the angular displacement introduced by the potential transformer, as will be explained later in this chapter.

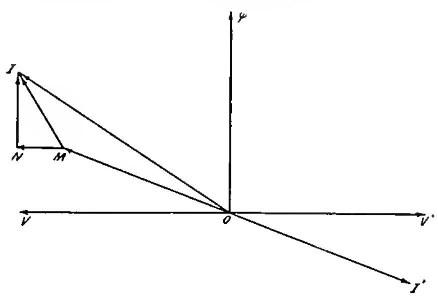


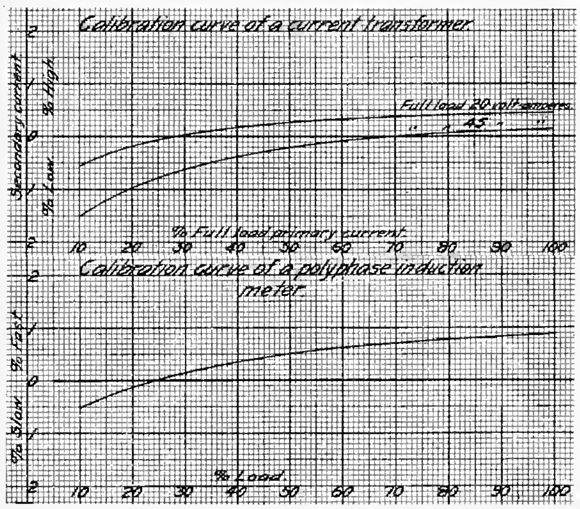
Fig. 99.

Fig. 99 is a vector diagram showing the phase relations of the currents in the primary and secondary of a current transformer; IM is a component of the primary, or line current which acts as exciting current for the transformer and is responsible for both errors above mentioned. In the figure,

OI = the primary or line current,
OI' = the secondary current,
$O\phi$ = the magnetic flux in the transformer core,
OV = the voltage of primary winding,
OV' = the voltage of the secondary winding,
IN = the magnetizing current,
NM = the energy component which supplies the losses of the transformer and the load.

One source of error is due to the fact that OI is not exactly 180 degrees displaced from OI', and therefore the current which flows through the meter (from the secondary side), will not have the proper phase relation with respect to the current in the potential coils of the meter. As already stated, however, for all practical purposes the error thus introduced is negligible except in the case of low power factors, and in transformers of poor design. It can be seen by referring to the above diagram that if the secondary circuit has the proper amount of inductance to cause the secondary current OI' to lag by the same angle that the exciting current, IM, lags, that the secondary current will be exactly 180 degrees out of phase with the primary current, which would result in there being no error from this cause.

The second error referred to, which is caused by the varying ratio of the transformer, is due to the exciting current, IM, not being effective in inducing current in the secondary winding; the secondary current being induced by the component, OM, of the primary current. If IM varied directly as the primary current, this error could be corrected by adjusting the ratio between the primary and secondary turns; such is not the case, however, and an error is introduced. Fig. 100 is a curve showing the accuracy of a well-designed current transformer. In calibrating watthour meters for use in connection with current transformers, the meter should be calibrated to register correctly on the flat part of the curve. There will then be a slight error at either end of the curve, that is, there will be an error on very light loads on or overloads, but if the meter is carefully calibrated in accordance with the curve of the transformer it will be accurate over the greater part of the range, and the error at either extreme will be small.



Figs. 100 and 101.

Fig. 100 shows a typical calibration curve of a good current transformer, and Fig. 101 shows the calibration curve of a standard induction watthour meter. These two curves are combined as shown in Fig. 102, the resultant curve, B, being the resultant calibration curve of the meter when used in connection with the transformer. It will be seen that if the meter is adjusted so that it will be a little slow on full load (about 0.5 per cent), and if the light load adjustment is set so that the meter will be slightly fast (about 0.5 per cent) on 10 per cent load, the resultant curve will be more nearly correct, and when a high degree of accuracy is required, this is recommended, the amount of such adjustment being determined by referring to the calibration curve of the transformer with which the meter is to be used.

It should be remembered that a current transformer must always have a load on its secondary side; if the meter or instrument with which it is being used should be disconnected while current is still on the primary, the transformer should either be disconnected from the line, or else have its secondary short-circuited. If the secondary is left open-circuited there will be no counter magneto-motive force from the secondary, consequently the magnetic flux will increase to such a degree that it will cause the iron core to become overheated to an extent that may injure the transformer.

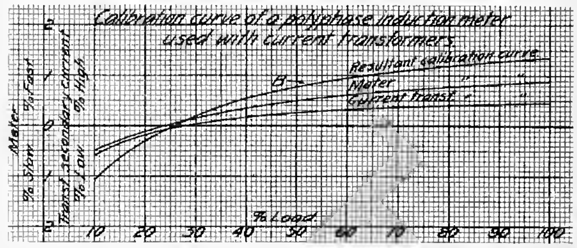


Fig. 102.

The load carried by potential transformers is constant, and if the load is light, the error in the transformer ratio will be very small. The secondary e.m.f. of the potential transformer leads the primary e.m.f. by a small angle, θ, Fig. 103; the angular displacement referred to in connection with current transformers is also leading; it therefore follows that the angular displacement in a potential transformer compensates, in a large degree, for the angular displacement in the current transformer; if this angular displacement is the same for both the current and potential transformers the error from this source will be entirely eliminated from the meter with which they are used.

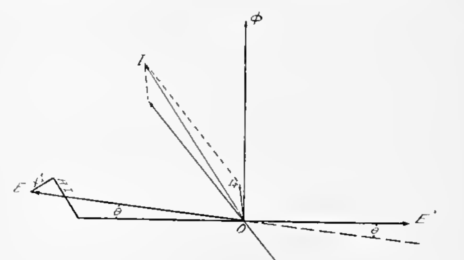


Fig. 103.

The angular displacement referred to depends upon the magnitude and character of the load imposed upon the transformer, as well as upon its design.

Fig. 103 shows a vector diagram of the regulation of a potential transformer, in which

OE=primary e.m.f.,
OE′=secondary e.m.f.,
OI=primary current,
OI′=secondary current,
RI=total resistance drop,
XI=total reactance drop,
θ=angular displacement between primary and secondary e.m.f.'s.

In using 5-ampere 110-volt meters with current and potential transformers and leaving the regular register on the meter it is necessary to use a multiplying constant, which, multiplied by the register reading, gives the kilowatt hours consumed. This multiplying constant is obtained by multiplying the ratio of the current transformer by the ratio of the potential transformer.

In order to obtain a multiplying constant of 10, 100 or 1,000 it is often necessary to use a special register and to change the disc constant of the meter. The new disc constant is obtained from the following formula:

$$K = \frac{100 \times \text{register ratio} \times \text{transformer ratio}}{10{,}000 \times C}$$

in which C is the multiplier of 10, 100 or 1,000.

Applying the above formula to an example we will take the case of a 5-ampere meter having a disc constant of K=.3, and used with a 20 : 1 ratio potential transformer and a 24 : 1 ratio current transformer, from which the "transformer ratio" in the formula will be (20 x 24)=480 : 1. Suppose a register is chosen having a ratio of 66 2-3, and a multiplier (C) of 100 is used. Substituting these values in the above formula we derive a value of K=.312, which should be used instead of K=.3, which would of course result in a slightly different operating speed of the disc.

(To be continued.)

HOW ANTONE DID IT.

(BY ANTONE'S BROTHER.)

Once upon a time, a little later than the time when the greatest of men did the water stunt, there happened to be a large company operating a smelter, principally by electric current, which was generated by a steam plant. Motors were used to drive the blowers for converters, and the molten ore was conveyed from the furnaces to the converters by electric driven cranes. The whole plant was situated in an arroyo, or small creek, and a large flood came down said arroyo or creek one night and the next day found the engine, boiler and dynamo rooms flooded with water, leaving about five feet of nice oozy mud in them. Fortunately, by hard work they managed to keep the water away from the furnaces and converters, which were on a little higher ground.

The chief engineer in charge of the electrical plant was a rather tony appearing gentleman, by the name of H. E. Doe, E .E. M. A., etc., which might not be his right name. Now, after Mr. Doe had spent some time in careful meditation, he solemnly informed the superintendent that the plant would not be able to start for at least six weeks, and as the ore would remain melted in the furnace probably three or four days, it meant that it would require about as long to get the ore out of the furnaces as it would to repair the electrical end of the plant.

The superintendent did not know anything about the electrical end of the business, but he did know Brother Antone, and where he was to be found. He wired him his troubles, and told him to come at once, which he did. The railroad station was some distance from the smelter, and when Brother Antone arrived at the station, he was met by a tall, lanky gentleman wearing gold-rimmed side lights, latest high-top boots, and the latest type in khaki, who introduced himself to Antone graciously, informing him that he was the chief engineer of the smelter, and volunteering the name of his alma mater, politely requesting the same information from Antone. Upon being informed that Antone was an orphan, he gave him a very patronizing look and commenced to tell him how he would go about getting things in shape, which was continued until they arrived at the smelter, where they found the superintendent making preparations to let the charge of the furnaces run on the floor which had some water on it. This might mean several thousand dollars' damage, to say nothing of the danger to life, but he was preparing for the last resort. Brother Antone advised him to wait a while until he looked around, and after a visit to the dynamo and engine rooms Antone advised him that he would have things in operation in twenty-four hours, when he told Brother Antone to get busy, which he did as follows:

There was several hundred cords of four-foot cordwood near the engine-house, and he started a bunch of men building a crib in the mud around the fronts of the boilers, filling in the chinks with gunny sacks, filled with hay, doing the same around the engines and dynamos, and as soon as he got the cribbing above the mud, put the men to dipping the mud out, starting fires in the boilers as soon as he got the mud out of the cribbing.

When the mud was removed from around the engines and dynamos, he took a hose and began to wash them down, as it would have required a couple of weeks' time to dig the mud out of the armature and field winding, and even after the job was done, more than likely the machines would have to be reinsulated.

The chief engineer began to object, graciously informing him that the machines would be ruined, but the superintendent preferred to take a chance on the electrical end, rather than lose some ten to twenty thousand on the other end, which he knew would be the case. So Antone went ahead.

After washing down the machines, steam was high enough to start them, which Antone did; and what the chief engineer thought was still worse, he short-circuited all the machines by putting a jumper across the terminals. But he ran the machines, which were 220 d.c., just fast enough to make as heavy a current flow as he thought they would stand, when immediately they began to steam and in about ten hours were dried out enough, so he put on a light lead for four hours or more, when he informed the superintendent that the machines would carry the power circuit, which they did.

EFFECT OF SUPERHEATED STEAM ON CAST-IRON AND STEEL.

BY JOHN PRIMROSE.

During the past eight years the writer has been in close touch with many plants, upwards of fifteen hundred installations using superheated steam, and in such a position that troubles would be promptly reported to him. Almost without exception these plants use cast-iron fittings in their pipe connections. The fact that no one of these plants ever reported troubles with their cast-iron fittings does not at all agree with the comparatively few instances where superheated steam has been charged with being the cause of trouble. In order that there should be no doubt about the absence of trouble due to superheat, letters were written to ten concerns known to have been passing superheated steam through cast-iron fittings for the past eight years, asking the following questions:

1. Are the tees and elbows and valves in branch and main steam lines leading from the boilers of cast-iron?

Seven answered yes; two replied that some fittings and valves were of cast iron and some of cast-steel, and one replied that the fittings were originally cast-iron, but that some tees had been changed to cast-steel, but stating positively that the change was not made because of any ill effects of superheated steam.

2. Are fittings of extra heavy or standard weight?

Nine replied that they used extra heavy fittings, and one standard weight.

3. What steam pressure do you ordinarily carry?

One used steam pressure of 100 pounds; six used 150 pounds; one used 165 pounds; one used 185 pounds and one used 200 pounds steam pressure.

4. Have you ever noticed any injurious effect of the superheated steam on valves or fittings?

Eight answered no; one that no trouble was experienced in fittings, but that valves with cast-iron bodies and brass seats were difficult to keep tight, and one reported no trouble further than the baking of a hard deposit on inside.

5. Have you ever found it necessary to replace any of these valves or fittings with cast-steel?

Eight answered that no fittings or valves had ever been replaced on account of superheated steam. One answered that they had replaced no fittings, but some globe valves, and one answered that they were replacing some fittings with cast steel, but upon further inquiry it was found that this was not because of ill effects of superheat, but because the steam mains were being changed to Van Stone Joints and they wished to change the fittings to standard length and deemed it advisable to use cast-steel.

6. Of what material are the gaskets in the steam line?

Seven used corrugated copper or bronze; two sheet packing, and one asbestos.

Ten letters were written and the answers are as reported above. Doubtless further inquiry would result in similar reports. Nearly all of the people written to have used superheated steam for eight years or more, the steam temperature corresponding to from 100 to 150 degrees of superheat.

The chief engineer in charge of a plant in the Middle West, of some 20,000 hp. writes that nothing has developed in any of the cast iron fittings to show that they are in any way effected by the use of superheated steam. This plant has been in operation about five years.

Such evidence as the foregoing proves pretty conclusively that superheated steam does not have an injurious effect on cast-iron. There seems to be no very good reason why it should. Several cast-iron fittings have failed when passing superheated steam. There is nothing extraordinary about this, and the failures are probably due to inferior metal, or to strains developed by expansion or contraction of the pipe lines, as suggested by Professor Hollis and Mr. Mann. These are much more plausible theories than that superheated steam at a temperature of 500 to 600 degrees Fahr. has any effect on the metal. Investigations by Mr. Outerbridge and and Professors Rugan and Carpenter, on the growth of cast-iron when repeatedly heated, start at 900 degrees C., 1652 degrees F. Such instances as the growth of grate bars, etc., are all at temperatures far exceeding anything used in superheated steam work for power plants. Samples of cast-iron taken from fittings passing superheated steam for years have been polished and micro-photographed before and after etching, and compared with samples treated in the same way, taken from fittings passing saturated steam. The expert report is that there is no evidence of a change in the carbon conditions, or of exposure to superheated steam, and in support of this a well-known foundryman gives his opinion that a temperature below 900 degrees Fahr. would not produce any effect in cast-iron. The tests of the famous Crane valve so often quoted are no proof of superheated steam being responsible for the failure. Test bars from the broken valve was compared with test bars taken from the same heat the valve was made from, and the valve was said to have weakened. This is no real test, because castings from different parts of the same heat, or, in fact, different parts of the same casting are known to vary in strength, and it is quite likely that fittings passing saturated steam, if compared on the same basis, would be found to have suffered greatly from the effect of saturated steam. It is unquestionably true that this valve must have been subjected to other influences besides superheated steam. It is rather remarkable that the body of the valve is said to have been weakened more than the flanges—the reason given is that the metal of the body was nearer the superheated steam. Is it not more reasonable to suppose that the metal of the body weakened more than that of the flanges, because it was supbjected to greater fatigue on account of expansion and contraction of the pipe?

Care should be exercised in the design of pipe lines to guard against over strain of the fittings from movement of the pipe due to expansion and contraction. Where long radius bands are the means of taking up this movement, pipe of the lightest possible weight consistent with safety should be used, thereby lessening the strain required to spring the pipe.

A better way of taking care of expansion than long radius bends, is to use ball and socket expan-

sion joints, which have the additional advantage of reducing the amount of piping.

The writer entirely agrees with Professor Hollis in charging strains due to expansion and contraction with the failure of certain fittings, and with Mr. Mann when he charges inferior fittings with the cause of failure in other cases and recommends the use of a good cast-iron containing a percentage of steel scrap for fittings passing superheated steam, as it is entirely in accord with the writer's experience.

THE MECHANICS OF THE STEAM ENGINE.

In its simplest form the steam engine consists of two chains of moving parts on links. One chain of links consists of the crank, which turns about the shaft and constrains the motion of the crankpin, the connecting rod, the crosshead and piston, which move as a unit, and lastly, the engine base, to which the various motions of these links are referred. The other chain of links is identical in action and consists of the eccentric, the eccentric-rod and the slide-valve, together with the base.

The first mentioned chain constitutes the driving mechanism of the engine and serves to transmit the motion which the steam imparts to the piston, a motion of rectilinear translation to a motion of pure rotation, which may be taken from the shaft by means of a pulley and belt, or maybe imparted directly to the rotating element of a dynamo.

The second chain of links is the controlling or actuating mechanism which serves to determine the nature and amount of the force which the steam imparts to the piston. This chain re-transfers the rotary motion of the shaft back to a translatory motion peculiarly related to the motion of the piston.

It is the purpose of these papers to investigate, first, the positions of the various links of each of the above chains when one link—as, for instance, the crank—has a certain assumed position, and then to discuss the relative velocities of the several links corresponding to this assumed position of the crank, and lastly to derive the accelerations—or changes in velocity—which the links are at such instants undergoing.

Since force is always necessary to produce acceleration in the mass of any material, it is but a natural step to the investigation of the forces and strains existing in the materials of which the links are constructed, and it is this knowledge of forces, together with the provisions for safety and yet efficiently constraining them, which makes the engineer of value to his employer.

As these papers are to be written primarily for the operating stationary engineers it will be our aim to avoid the use of higher mathematics, favoring in their stead such graphical analyses as are available.

In Fig. I the line M to B represents the base of a piston-crank chain of links. CO is the crank with shaft at O, W is the crosshead, the motion of which is identical with that of the piston; and WC the connecting-rod.

To determine the position or path of successive positions occupied by any point for assumed positions of, say, the crank pin, it is merely necessary to draw out to scale the various parts for such assumed positions. It is obvious that the successive positions of the crankpin will describe the circle CGBHA about the shaft O, and other points on the crank will describe smaller concentric circles. The point C being common to both the crank and the connecting rod, the rod at this position must likewise describe a circle.

The crosshead W has a motion of translation, the limits of which are shown at M and N, and the distance of travel being equal to AB or double the crank throw. The successive positions of the crosshead for the various positions of the crank pin in its circular orbit may be found by laying the various lengths out to scale on a drawing board and actually measuring the travel MW. A simpler method of determining this value is by the use of the arcs AA' and BB' drawn with a radius equal to the length of the connecting rod. By drawing a horizontal line through the crank pin C the distance A'C to the curve will always be equivalent to the travel of the crosshead from the head end of the stroke. The distance CB. is, of course, the corresponding travel from the crank end of the stroke. It will be noted that when the crank has passed through 90 degrees of its travel from the head end dead center, or A, that the crosshead will have traveled through a distance AG, which is considerably greater than the remaining distance GB to the crank end dead center.

In the diagram AD representes the longitudinal travel of the point C or crank end of the connecting rod.

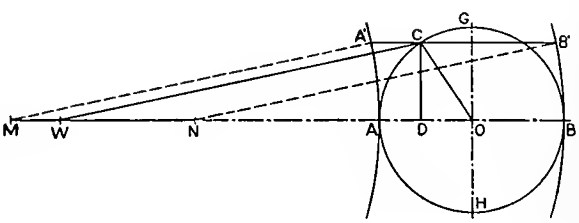


Fig. 1.

Since the motion of one end of the rod is one of pure translation and the other end travels in a circle, the intermediate points will travel in ellipses, which will vary between the two extremes of a straight line and a circle.

The path of any such intermediate point may be determined by laying out successive positions of the parts, and connecting the points so determined with a smooth curve.

By erecting a perpendicular at A and drawing an arc from C to the line MB., such as would be described by the crank end of the connecting rod were it disconnected and let fall, the horizontal distance between such perpendicular and this arc would represent the horizontal travel of an equally elevated point in the rod.

All these relations of position, while very simple, are essential to a thorough understanding of the velocity and acceleration diagrams which will be taken up hereafter.

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Newspaper Jargon

Electricity is now so widely used that its technical terms, hitherto sacred to the scientist, are becoming an integral part of our common speech, especially through the medium of the daily press. Unfortunately, the average newspaper man knows but little about the electric power that takes him to his work, brings him his news, lights his office, operates his linotype and prints his paper. The vagueness of his writings reflects and transmits his ignorance to his readers, who thus unconsciously acquire much misinformation.

How often do we read of "an electric current of ten thousand volts"! It would be just as sensible to speak of water of one hundred pounds, heat quantity of one hundred degrees or money of six per cent when we intend to convey the idea of amount. The correct words denoting quantity which should be used in these connections are an ampere of electricity, a quart or a cubic foot of water, a British thermal unit or a calorie of heat and a dollar or a cent of money. Each of these quantities has no energy or can do no work, which is merely energy applied to a particular purpose until it is moved by some force, such as the voltage of electricty, the heat of water, the temperature of steam or the interest of money.

Energy is an eternal Proteus, indestructible, yet ever assuming new forms. The chemical energy in the cell of a battery is converted to electrical energy, which, in turn, becomes thermal, mechanical or radiant, at our will; the radiant energy in light is transformed to chemical energy in the photographic plate, thermal energy in the conservatory, mechanical energy in the radiometer and electrical energy by indirect means. It is not, however, until energy or work is performed for a definite time that it becomes measurable as power. One ampere under a pressure of one volt for one hour gives the watthour; ten cubic feet per second under a head of ninety feet gives about one hundred horsepower, which is also approximately the power necessary to heat one pound of water seventy degrees Fahrenheit in one second; one dollar at five per cent interest compounded semi-annually has the power of two dollars after fourteen years. Many other examples can be cited, but we believe that these clearly demonstrate the difference between an ampere, a volt, a watt and a watt-hour, or in other words the distinction between a quantity, a force, its energy and its power.

It is argued that common acceptance of a word's definition constitutes sufficient evidence as to its correctness, but this criterion should not be applied to technical words of recognized meaning which may find place in colloquial English. Anyone guilty of loosely using such definite terms not only subjects himself to well deserved ridicule, but also displays his ignorance of a matter upon which he is dependent for many modern conveniences.

PERSONALS.

C. E. Wiggin of John R. Cole & Co. is at Seattle.

E. G. Wllliams, an electrical engineer of New York City, is at San Francisco.

W. J. McCabe, an electrical engineer, recently arrived at San Francisco from Duluth, Minn.

William H. Hoops, an electrical engineer, is a recent San Francisco arrival from Chicago.

Frank Fowden, manager of Brooks-Follis Company, left this week for Eureka, on pleasure bent.

W. E. Osburn, who is in the electrical business at Woodland, was a San Francisco visitor last week.

A. D. Bowen, who was at one time general manager of the Ocean Shore Railway, is a San Francisco visitor.

W. S. Heger, Pacific Coast manager for the Allis-Chalmers Company, is spending a few days in Southern California.

Thomas Mirk, of Hunt, Mirk & Co., has gone to San Diego, where his firm is erecting an electric power plant.

Leon Bly of Red Bluff, who has electric power and irrigation interests in Northern California, was a recent San Francisco visitor.

Sidney Sprout, electrical engineer, has gone to Los Angeles on engineering business and will return to San Francisco next week.

A. S. Kalenhorn, electrical engineer for the Reno Power, Light and Water Company of Reno, Nevada, visited San Francisco this week.

Delos A. Chappelle, who is interested in hydro-electric developments, has returned to Mono County after visiting his San Francisco office.

E. M. Frazer, an inventor and manufacturer of electric elevators, has arrived from the East and may spend some time at San Francisco.

F. E. Vickers, assistant engineer of the General Electric Company's San Francisco office, has returned from a trip to New York and other Eastern cities.

E. G. Dewald, in charge of the water wheel department of the Allis-Chalmers Company on the Pacific Coast, is again at the company's San Francisco office after a trip to the factory at Milwaukee, Wis.

W. G. B. Euler has taken charge of the Big Bend plant of the Great Western Power Company. Mr. Euler has been with the General Electric Company for a nnmber of years as an engineer of construction.

E. G. Williams, who has general charge of J. G. White & Co.'s engineering bnsiness, has just arrived at the San Francisco office. J. W. Burke, engineer with the same corporation, arrived last week from Denver.

H. G. Boardman is chief engineer for large electric power and gold-dredging interests in Alaska. He a rived at San Francisco for the purpose of purchasing machinery and supplies. He has his headquarters at Dawson, Yukon Territory.

Charles P. Morrill, formerly Santa Rosa Manager for the Pacific Telephone and Telegraph Company, has been promoted to the position of assistant to the general superintendent at the San Francisco offices. A. F. Lafranchi, manager of the Petaluma exchange, has taken Mr. Morrill's place at Santa Rosa.

Kamakichi Takata, of Takata & Co., the Japanese agents of the Westinghouse Electric and Manufacturing Company, spent a few days last week inspecting the factories and power plants of San Francisco. S. Furmi, of Takata & Co.'s New York office, came West to meet the head of the firm and left with Mr. Takata for the East May 23.

Among the San Francisco engineers who went to Los Angeles during the past week to attend the seventh annual convention of the California State Association of the National Association of Stationary Engineers were: H. N. Saville, William Millner, Herman Nothig, William Jenkins, Charles Knight, Frank Carmody and Charles Dick.

MEETING OF NORTHWEST ELECTRIC LIGHT AND POWER ASSOCIATION.

The annual convention of the Northwest Electric Light and Power Association will be held this year on the steamer Queen leaving Seattle the evening of August 26th and returning the morning of August 29th. The boat has been chartered for the trip and will visit the various Sound cities with stop-overs at each place. The cost of the entire trip inclnding berth and meals will be but $10 a person. This gives au excellent opportunity for the delegates to get acquainted with each other and discnss the business and operative problems that confront them. An orchestra will be taken on the trip and everything possible done for the entertainment of the members. Part of the freight deck has been assigned to the varions supply companies who are members of the Association, where they will he permitted to install such exhibits as they choose. The program as outlined includes papers on "Long Distance Transmission," "Depreciation," "The Rate Question," "Employers' Liability," "Methods of Getting Business" and "Conservation," all by speakers of ability. It is expected, however, that the greatest good will be accomplished by the opportunity the three days' trip will give for discussion.

NEW CATALOGUES.

"Attitude of Central Stations Toward Electric Automobiles" is the subject of Bnlletin No. 123 from the Electric Storage Battery Company. In it is told the profitable results obtained hy the electric lighting company at Rochester, N. Y.

Bnlletin 7B from the Engineering Department of the National Electric Lamp Association presents valuable data on illumination, so arranged and condensed that the correct illumination of any place may be qnickly calculated. In addition to excellent tables and formulas this bulletin shows typical lamps and reflectors for various uses.

"High Vacuum Surface Condensers for Steam Turbines" is the title of Bulletin 106, published by the Wheeler Condenser and Engineering Company of Carteret, N. J. The high steam economy obtainer by steam turbines with vacuums of 28 to 29 inches is pointed out, while on the other hand it is shown that in obtaining these high vacunms there should be no unnecessary power consumption by the condenser auxiliaries, or excessive amounts of water used for cooling purposes. This pamphlet describes arrangements of the tube surface, the nse of rain plates and other means recently devised for obtaining these results.

TRADE NOTE.

R. B. Guernsey has been appointed San Francisco representative of the C. H. Wheeler Manufacturing Company of Philadelphia, succeeding Frank R. Wheeler, who has been transferred to the Chicago office of the company as manager.

The Los Angeles Gas & Electric Corporation have purchased from the C. H. Wheeler Manufacturing Company two complete surface condensing units for two large compound gas compressors recently installed. Each unit includes the new Pratt rotrex vacuum pump.

The General Electric Company has closed a contract for an additional 12,000 kw. Curtis tnrbine generating unit, which is to be installed in the San Francisco Gas and Electric Company's Station "A," under the supervision of J. G. White & Co. The new vertical turbine has a condenser base and is rated as follows: A. T. B. 10, 12,000 kw., 720 r.p.m., 11,000 v.

BOOKS RECEIVED.

Dynamo Building for Amateurs. By A. J. Weed; 81 pages; 4½x7½; 64 illustrations. Norman W. Henley Publishing Company, New York, and Technical Book Shop, San Francisco. Price, cloth, $1.00; paper, 50 cents.

As implied by the title this is a manual of practical instruction on building a small dynamo or motor, the machine work of which can be done on a small foot lathe. In it are working dimensional drawings and detailed directions for making a 50-watt dynamo.

The Control of Use of Stream Waters in the United States. By Russell L. Dunn; 65-page pamphlet published by the author, Metropolis Bank Building, San Francisco; sold by Technical Book Shop, San Francisco. Price, 50 cents.

This dissertation deals with the subject of conservation of water power from the standpoint of the company that is formed to develop such power, but is hindered by governmental restrictions. Two points specially emphasized are the prevalent misunderstanding as to the definition of a water power site and the question of state ownership of water rights over which federal jurisdiction is now being extended. Included in it is a comprehensive summary of the laws relative to water appropriation and use in California. In its entirety it is an able exponent of the "other side" of what hitherto has been largely a one-sided argument.

Report on Foreign Labor Conditions. By Harris Weinstock; 157 pages; 5½x9. Published by State Printer, Sacramento, California.

In 1908 Governor Jas. M. Gillett appointed Mr. Harris Weinstock Special Labor Commissioner to examine into the labor conditions and labor laws of foreign countries and report his conclusions as to remedies for strikes and lockouts. In this volume is embodied the results of his investigations in Italy, Russia, Austria, Germany, Belgium, France, England, Australia and New Zealand. The statement of conditions in these countries is most interesting, as are also the author's conclusions. These embrace an indorsement of the principle of State intervention in labor disputes, including public inquiry in labor disputes before they reach the serious stage of a strike or lockout.

Municipal Franchises. By Delos F. Wilcox; 710 pages; 5x8. Engineering News Book Department, New York and Technical Book Shop, San Francisco. Price, $5.00.

Herein is given a description of the terms and conditions upon which private corporations enjoy special privileges in American cities. The work is divided into two volumes, this, the first, containing an introductory analysis of the modes of acquiring franchise rights, of the nature of franchises and the various possible means of restricting public utility monopolies under private operation. The several classes of municipal franchises are then discussed in detail, this volume dealing with wire and pipe franchises, the former including the telephone, telegraph, lighting heat and power and the latter water supply, sewers, central heating, refrigeration, pneumatic tubes, oil lines and gas. The second volume, to come within a year, will discuss transportation and terminal franchises together with observations on the taxation and control of public utilities. In each case a brief sketch is given of the history and importance of the utility, followed by examples of typical franchises in actual operation in different American cities. The author, who is Chief of the Bureau of Franchises of the Public Service Commission for the first district of New York, is a recognized authority on this and kindred subjects. He believes that "a public franchise is a public trust" and he indicates how private operation of public utilities may be best regulated. As a reference work it is valuable alike to the engineer and the lawyer, giving the most comprehensive summary of American franchise provisions yet published. It presents pertinent facts and deduces rational conclusions on a subject which is daily increasing in popular interest.

Auto-Transformer Design. By A. H. Avery; 60 pages; 5½x8½; 25 illustrations. Spon & Chamberlain, New York and Technical Book Shop, San Francisco. Price, $1.50.

Anyone who has ever tried to make a small transformer and found how little practical information is available will appreciate this book. The designers of large transformers for manufacturing companies have reduced their work to a science, but the individual who wishes to make his own apparatus has great difficulty in understanding and adapting their information to his needs. This want is admirably supplied in this volume for small transformers in general and auto-transformers in particular. The book contains six chapters. After defining and comparing the different types of transformers and discussing the advantages of transforming to low pressure for lighting, the author develops the elementary theory and presents the fundamental formulae necessary, this including a clear explanation of iron and copper calculations. In the chapter on practical design a typical problem is worked out, detailing every step in the calculation. This is supplemented by a simple explanation of how the efficiency of the transformer may be determined. The final chapter gives practical constructional details, including core assembling, coil winding, insulating, mounting and enclosing, well illustrated by line cuts and half tones. The text substitutes for the rule of thumb methods hitherto used rational explanations and practical directions which should enable anyone not only to make an auto-transformer, but also understand its theory.

American Producer Gas Practice. By Nisbet Latta; 539 pages; 7½x10½; 247 illustrations. D. Van Nostrand Company, New York and Technical Book Shop, San Francisco. Price, $6.00.

Nisbet Lotta is one of the foremost American authorities on gas engines and gas producers. In this volume he has ably delineated typical practice couched in such language that even the layman may understand. It is a welcome relief upon turning to the first page to find that the author omits all history, ancient and otherwise, and proceeds at once with the practical features of producer design and operation. The book consists of twenty-two chapters and an appendix. These are concerned respectively with producer operation, cleaning the gas, works details, producer types, moving gases, solid fuels, physical and chemical properties of gases, gas analysis, gas power, gas engines, industrial gas applications, furnaces and kilns, burning lime and cement, pre-heating air, combustion, properties and measurement of heat, data on pipes, flues and chimneys, useful tables and oil fuel producer gas. The treatment of each individual subject is as comprehensive as is the handling of the entire field as above outlined. Written description is well-supplemented by reproductions from photographs and drawings. With so much to commend it is unfortunate that the text should be marred by a number of typographical errors, which should be corrected in future editions to which the book is undoubtedly destined. For instance, in the appendix on oil fuel producer gas, which is particularly interesting to Pacific Coast engineers in that it describes the Jones oil gas set, the Nix-Frost producer and the Amet Ensign producer, we find Professor Durand's name spelled "Durant," and Bakersfield given as "Bakersville." Doubt is at once created regarding the correctness of the names of individuals and places in other localities with which we may not be familiar. Except for these minor defects, this work should prove of value to everyone operating or contemplating the operation of a producer gas plant.

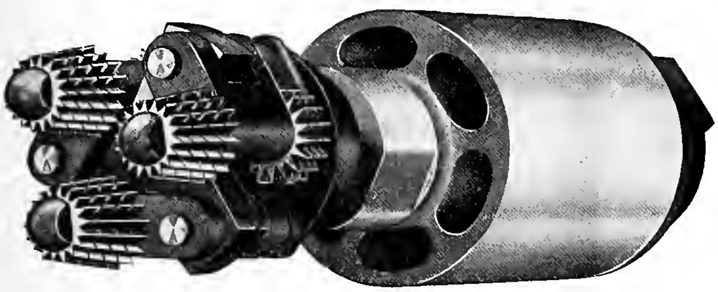
"California for the Settler" is the title of a handsomely illustrated book of 100 pages issued for free distribution by the advertising department of the Southern Pacific Company. In it are detailed the advantages of rural life in this State.

INDUSTRIAL

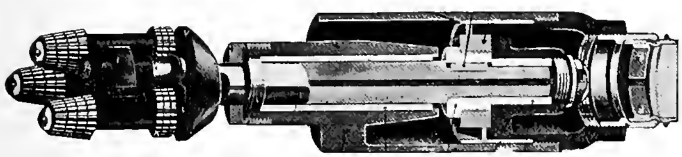
A NEW FORM OF HEAD FOR BOILER TUBE CLEANERS.

The Lagonda Manufacturing Company, of Springfield, Ohio, have recently put out a new boiler tube cleaner equipped with what is known as the "Quick Repair Head." This head is the result of several years of experimenting, and is said to be the simplest and most compact head for use on turbine tube cleaners that has yet been brought out. The head is attached to the cleaner turbine proper by means of the coupling and an adapter. As can be seen from the accompanying drawing, a spider screws directly into the coupling, and has three arms on the end of which are attached the swinging arms carrying the cutter wheels. There are four cutters on each swinging arm; the front one being of the cone pattern, is the first to attack the scale and loosen it. Each cone cutter is then followed by three star cutters which remove the scale down to the metal, leaving a bright, polished surface.

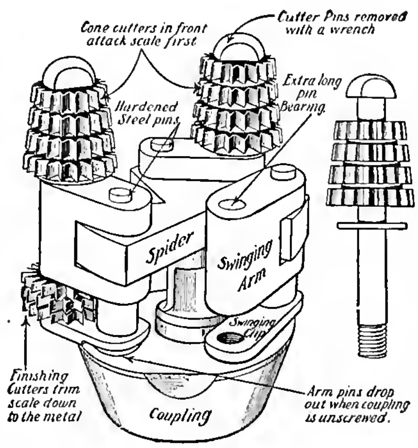
The most important feature of this head is the ease with which new cutters can be inserted. The cutter pin can quickly be removed by means of a wrench and all of the cutter wheels taken out. In case it is necessary to take the entire head apart it is only necessary to unscrew the spider from the coupling; this allows the three arm pins to drop out and the whole head is dismantled. There are no rivets or small parts used and the makers furnish an extra supply of sharp cutter wheels with each head. As mentioned before, it is but the work of a minute to remove one of the pins and insert new sharp cutters. Keeping the head equipped with sharp cutters results in a marked saving in the time necessary to remove a given amount of scale from boiler tubes.



The Quick Repair Head Attached to a Weinland Water Turbine.



Sectional View of Weinland Thrust-Bearing Turbine Cleaner with a Quick Repair Head Attached.



The Quick Repair Head with One of the Cutter Pins Removed

The quick repair head is compact and heavily built. The arms are thrown out against the scale by the action of centrifugal force. This causes the cutter wheels to bear firmly against the scale, but should a constricted part of the tube be met the arms fold in and do not injure the boiler tube in the least. The fly-wheel effect of a compact head like this is quite noticeable. When exceptionally hard scale is encountered it is only necessary to back the cleaner out a little, and let the head speed up and when it is forced against the scale again, it is generally found that the cleaner will eat its way through without any further trouble.

Those who are not familiar with the turbine construction may get a good idea of this from the cut of the Weinland thrust-bearing cleaner with quick repair head.

Charles C. Moore & Co., engineers are General Pacific Coast Agents for same.

TRADE NOTES.

The Board of Public Works of Los Angeles, Cal., has recently placed an order with Allis-Chalmers Company for twenty-one 440-volt, 3-phase, 60-cycle, belted induction motors for use in connection with the work on the new water supply aqueduct. Seven of these are 125 h.p. and the rest range down to 10 hp.

The Electric Storage Battery Company announces that it has opened two new sales offices, one at No. 729 Ford Building, Detroit, Mich., and another at 1424 Wazee street, Denver, Colo. The increasing use of the "Chloride Accumulator" and "Tudor Accumulator" for central stations, telephones, railways, and an enormous increase in the use of the "Exide" battery for electric vehicles, gas engine ignition, etc., has made it advisable to establish these offices, so that customers in adjacent territory will be better served. A stock of battery material will be carried in Denver from which orders can be promptly filled. The addition of these offices as well as the St. Louis "Exide" storeroom recently opened at Sixteenth and Pine streets materially increases the facilities of this company in the West.

It has been announced that the 12,000-kw. generating unit, which is to be installed in the Southern California Edison Company's new power station at Long Beach, is to be furnished by the General Electric Company. The contract calls for the following: One A. T. B. 12,000-kw., 750-r.p.m., 11,000-v., 3-phase, 50-cycle Curtis steam turbo-generator with condenser base. This turbine will have a continuous output of 15,000 k.v.a. at 80 per cent power factor, operating at 200 pounds steam pressure with 1½ pounds back pressure. The superheater will supply steam at 125 degrees. The contract include, also, two exciters, each consisting of a Curtis steam turbine driving a 4-pole, 125-kw., 125-v. shunt wound generator. The General Electric Company will supply for the above plant seven 2,000-kw., 50-cycle, forced oil, single-phase transformers. The voltages are 40,000 v. slant, 400 v. 70,000 v. with 11,000 v secondary.

NEWS NOTES

INCORPORATIONS.

MISSOULA, MONT.—The Clark-Missoula Power Company has been incorporated for $6,000,000 by W. A. Clark of Butte. The company is formed for promoting the new street railway here.

RIVERSIDE, CAL.—The Orange Heights Water Company has been incorporated by G. R. Murdock, F. E. Palmer, J. W. Long, J. H. Fairchild and E. H. Bagby, all of Los Angeles. The capital stock is $125,000.

SANTA FE, N. M.—The San Luis Power and Water Company, with a capital of $1,000,000, has been incorporated by F. E. Brooks, Gerald and Fred Hughes, F. C. Moffiar, H. G. Lunt and H. A. Smith. The company's headquarters is at Colorado Springs, Colo., with W. F. Meyer as New Mexican agent. The company will operate in El Paso and Costilla Counties, Colo.

SAN MATEO, CAL.—The rumor that the San Mateo Water Company had taken over the holdings of the Burlingame Water Company was practically authenticated when the Peninsula Water Company filed articles of incorporation in Redwood City. The incorporators of the new company are the same as of the San Mateo Water Company—Joseph Levy, William F. Turbull, H. N. Royden, J. A. Foster and Charles N. Kirkbride. The capital of the new corporation is $1,000,000.

TRANSMISSION.

THOMPSON, MONT.—Senator Dolan of Missoula and others contemplate the erection of a large power plant here.

SHERIDAN, MONT.—O. B. Preston, president of the Municipal lighting plant of St. Johns, Mich., will establish a power plant here and supply the city with light.

NORTH YAKIMA, WASH.—A deed has been filed for record transferring all the property of the Northwestern Corporation in this section to the Yakima-Pasco Power Company.

PORT ALBERNI, B. C.—A. E. Waterhouse, of Seattle, has applied for a record on the Sproat River of 500 inches, with the intention of erecting an electric power plant to supply Port Alberni.

VICTORIA, B. C.—Bids will be received up to June 6th by the Minister of Public Works for the construction of a transmission line for the purpose of furnishing electricity for the hospital for the insane at Coquitlam.

GRANGEVILLE, IDA.—A. W. Trine announces that Eastern capital has become interested in the Snake River power project near the mouth of the Salmon River and that development work will be started soon.

COEUR D'ALENE, IDA.—The Coeur d'Alene Indian Reservation Settlers' Association, Wm. Masi, Jr., of Spokane, president, is preparing to install electric power and telephone lines, establish schools, etc., on the reserve.

SAN BERNARDINO, CAL.—The Arrowhead Reservoir and Power Company has filed trust deeds to the amount of $2,000,000 to raise money for constructing additional tunnels and building outlets for power and irrigation purposes.

TACOMA, WASH.—The City Commissioners are considering plans for the purchase of water rights on the White River, ten miles above Buckley, owned by P. H. Hebb and offered to the city for $900,000. The proposed power plant will develop 100,000 hp. at a cost of $2,000,000.

ORLEANS, CAL.—The company that has taken up the water power at Ishi Pishi Falls has had favorable reports sent in by the Government officers and expects before long to receive its permit, when active operations will begin. This means and expenditure of over $1,000,000 in Humboldt County, the permanent employment of hundreds of men and the building of factories, probably near Trinidad. The company will divert the water from the river above the falls into a flume 16 feet wide and 12 feet deep, tunnel through Sugar Loaf mountain and carry water to the next falls, a distance of a mile, where the pressure will give them 50,000 hp. all the year. The rock tunnel will also be 12x16 feet and will be 1500 feet long.

TRANSPORTATION.

SPOKANE.—The Okanogan Electric Company has applied for a franchise for a track on Nettleton street.

BOZEMAN, MONT.—The Gallatin Valley Electric Railway has completed plans for the erection of a depot in this city.

MARSHFIELD, ORE.—The Council has granted the Coos Bay Rapid Transit Company a franchise for building an electric line in Marshfield.

EUGENE, ORE.—The City Council has granted a franchise providing for the College Hill loop, which will add about six miles to the present street car system.

BAKERSFIELD, CAL.—A new franchise has been granted the Power, Transit and Light Company for an extension of its lines so that cars may be run to the fair grounds.

STOCKTON, CAL.—The Central California Traction Company has applied for a fifty-year franchise for an electric line on the streets and highways of San Joaquin County.

NEW WESTMINSTER, B. C.—It is announced that bids are to be asked soon for the construction of the proposed $80,000 depot of the British Columbia Electric Railway here.

SAN DIEGO, CAL.—The City Council has passed an ordinance granting to the San Diego Electric Company a street railway franchise along and up K street, Twenty-second and other streets.

HOOD RIVER, ORE.—The Hood River Electric Light, Power and Water Company has been sold to the Hood River Power and Water Company. One of the projects of the company is the construction of an electric railway.

LEWISTON, MONT.—E. H. Begeman, a capitalist from Holland, has announced his intention of building an electric road between this place and Holland, and residents of this place have agreed to subscribe $100,000 toward the project.

RAYMOND, WASH.—P. E. Hall, Jr., owner of the South Bend electirc lighting system, has applied for a franchise for a term of forty-five years, to construct and operate an electric street railway system in Raymond.

SEATTLE.—C. H. Shields of the Spokane Grain and Fuel Company, and others propose to construct an electric railway to Green Lake via Fourth avenue and a tunnel under Queen Anne hill to Evanston avenue, crossing the canal at Etruria street.

LOS ANGELES, CAL.—The line of the Los Angeles Railway which now extends to the intersection of Thirty-ninth street and Vermont avenue will be extended to Western from Vermont avenue. The track will be double and more than a mile in length.

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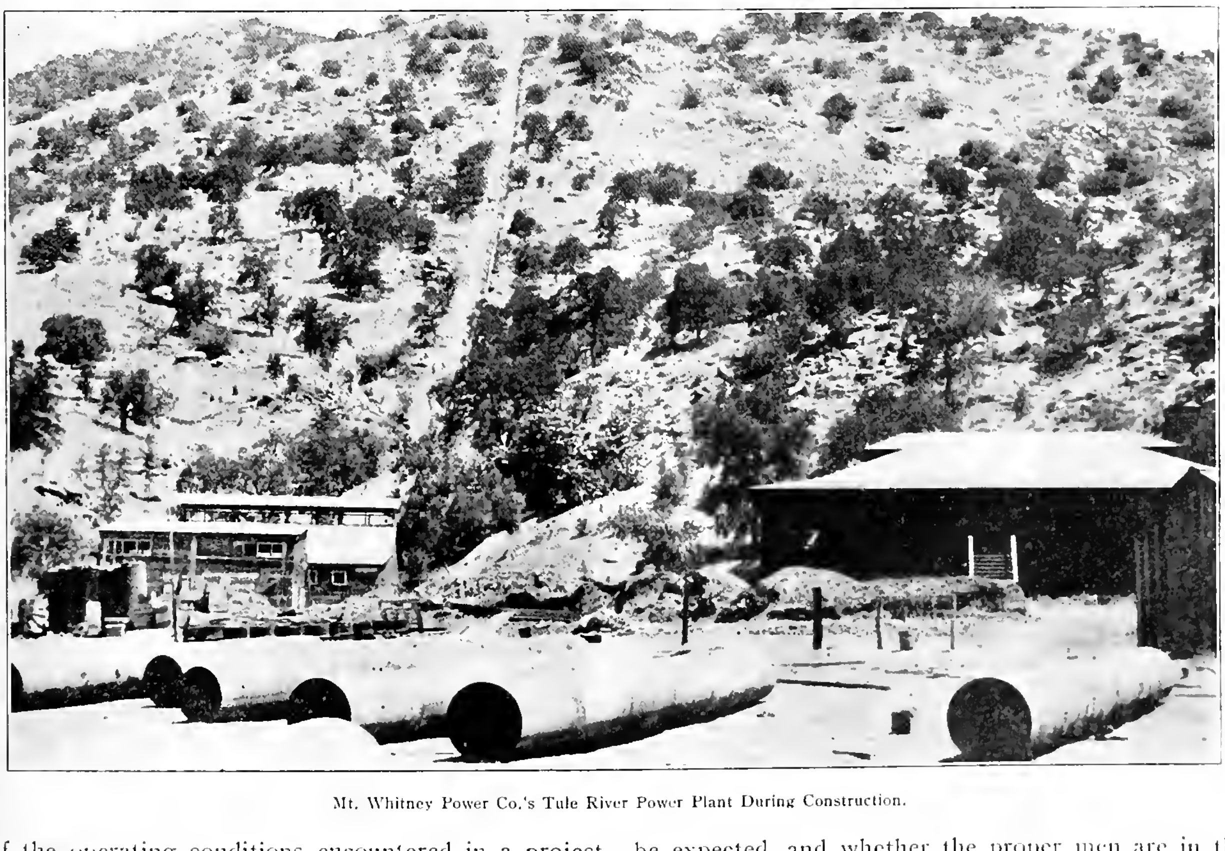
HYDRO-ELECTRIC POWER AS APPLIED TO IRRIGATION[1]

BY JOHN COFFEE HAYES.

Among the many uses to which hydro-electric power is being applied, that of electrically pumped water for irrigation is being advocated at present in a great many instances; and while the mere pumping of the water is so simple as to be hardly worthy of discussion, it may be of interest to point out some of the operating conditions encountered in a project formed chiefly for this purpose.



Mt. Whitney Power Co.'s Tule River Power Plant During Construction.

A hydro-electric system to supply power for pumping water for irrigation will usually be required to build up its own market in the territory served, and it is manifestly necessary at the outset to carefully study the territory. Usually some pioneer work by progressive farmers will show what the land is capable of producing, but the greater part of the territory will consist of barren country planted to grain, or used for grazing purposes, with here and there a town. This land is in large holdings, and the first thing to be determined is the amount of subdivision which may be expected, and whether the proper men are in the field to bring this subdivision about. The character of the land is, of course, of primary importance and the percentage of good land should be carefully determined. Irrigated land should have a slight slope for distributing the water and must be reasonably smooth. Hard pan near the surface must be guarded against, as it generally denotes a rather poor quality of soil. The adaptability of the soil for different products and

[1]Abstract of paper read at Pacific Coast meeting A. I. E. E., May 6, 1910.

the climate should be considered, yet data on these two points are hard to get and are usually unreliable. Tests and analysis of the soil would seem to be the natural way of determining its adaptability to the different products, but the agriculturist pays very little attention to these analyses, and has apparently a good reason for this, as they are often unreliable.

In the San Joaquin and Sacramento valleys it has been demonstrated that almost any kind of products may be raised on the good lands. Only a small portion of this land has been planted to citrus fruits, but small groves may be found along the entire length of the valley, and it would therefore seem as though it were all adapted to this class of products if water is applied. The best conditions seem to exist, however, where the mountains rise abruptly from the valley, and the level flat land extends up to the foothills, for, where a long stretch or rolling country lies between the plains and the hills, hard pan and bedrocks are generally very much in evidence.

Due to the fact that the oranges in the San Joaquin valley ripen and are marketed a full month earlier than those in the southern part of the State, they bring exceedingly good prices, and the growth of this industry is very rapid. The present citrus districts, as in fact is most of the land in the citrus belt, are above the existing irrigation canals, which in most instances divert all of the water available from the rivers, and are therefore entirely dependent on ground waters for irrigation; and, as the profits from this crop warrant a large expenditure, it is naturally the best market for power for pumping purposes. Aside from citrus fruits, all kinds of high-class products, such as deciduous fruits, berries, vegetables, nuts, vines and alfalfa are to some extent also irrigated by pumped ground water.

The amount of water required for the irrigation of different products varies to such an extent in the different communities that it is impossible to get any figures which would be at all accurate. The character of the soil is accountable for the difference to a large extent, but the cost of water and the personal equation are accountable to a very much larger extent. There is usually a marked tendency to the overuse of water. The duty of irrigation water in California is believed to average about 2 ft. in depth in addition to the average rainfall.

In the Imperial valley, in 1906, 120,000 acres were irrigated and a total average depth of 2.04 ft. was used, the main crop being grain. In San Diego county on land planted to citrus fruits an average depth of 1.5 ft. was used from 1889 to 1899. Around Los Angeles it is estimated that an average depth of 2.4 ft. is used.

In the Modesto and Turlock districts as much as 8 ft. to 10 ft. in depth was used at the start, but in 1908 the depth varied from 1.2 ft. to 3.6 ft. In the Fresno district very little water is applied to the surface of the land at present, the land being sub-irrigated by seepage from the canals.

The San Joaquin and Sacramento valleys are favorable storage basins for ground waters, as the only outlet is the San Francisco bay through the narrow straits of Corquinez. The elevation of the Lindsay district two hundred and fifty miles away is about 300 ft., and the ground waters must, therefore, of necessity travel very slowly and be in large quantities.

In determining the policies and the scope of a proposed hydro-electric system for the supply of power for pumped irrigation, it is necessary to determine at the outset the exact territory to be served and the general policies to be followed as regards charges, contracts, extensions, etc., or, in other words, a definite goal must be set, the power company must do everything possible to assist development, and any inhabitant in any section of the territory must be supplied with power whenever it is required. Therefore, the power system simply grows up with the country, and while this growth is taking place (it of necessity must take many years), it must be considered that the power system is in course of construction during the entire period. This is the main feature in which the power project depending entirely upon an irrigation market differs from the project supplying ordinary commercial business in an already well settled community, and this is a difference which is seldom fully understood and the time element not fully provided for.

The Hydro-Electric System.

The character of construction of a system depends entirely on the class of market, and for irrigation a slight discontinuance of service is not serious, therefore a light construction is permissible. The generating stations at the outset should be of a fairly permanent character, but the distributing system may and actually should be of a light and in many cases even bordering on a temporary character, as it is necessary to economize in every way at the outset to warrant the low rate which it is necessary to charge in order that the market may be developed; for it is necessary at the outset to establish a rate which will continue in effect when the system is fully developed. Even the expense of the generating stations may be reduced to a considerable extent at first, and as the system increases and the market becomes concentrated, improvements of a more permanent nature may be added.

Notwithstanding this, the writer has heard engineers of standing make the broad statement that there was no excuse for the use of a wooden flume and that a tunnel was the only proper thing; also that certain plants were altogether too flimsy and temporary in their design, and that the wooden pole line was entirely obsolete. When these statements are made, the writer cannot but think that the assertions are prompted by a lack of regard for the first principle of engineering, namely, economy. Every one who has had any experience with the wooden flume knows the many interruptions of service caused by it, yet, if constant service is not absolutely necessary, what possible type of construction can compare with the flume. It is short lived, but several can be built for the cost of a tunnel, and during the early life of a transmission system every dollar counts. If the system warrants a tunnel, it may be constructed during the life of the flume to take its place. Of course, if the system depends entirely upon one power plant, the replacement of the flume is both difficult and expensive, but few existing systems of any importance rely entirely on one plant, and there is usually sufficient capacity available during certain periods of the year to allow for the shutdown of one station. Also an auxiliary

steam plant is often cheaper than a tunnel and much more useful.

Wooden pole lines are also perfectly reliable in our California climate and are a very worthy substitute for the steel tower lines in respect to business development, and there is nothing to prevent the construction of the tower line when the wooden pole has outlived its usefulness; no interruption of service is necessary, as the right of way should be wide enough to accommodate both lines.

Among the different parts of the system where considerable expense may be saved is the switching gear, which may be extremely simple at the outset and

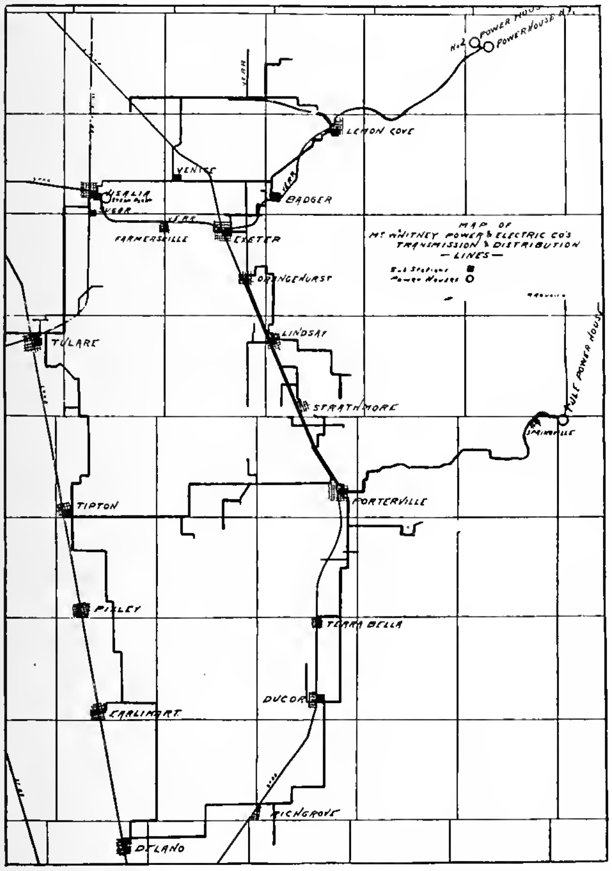


Fig. 1.

still ample. A small galvanized iron building on a wood frame is a thoroughly satisfactory building for the pioneer substation, which can be replaced by a permanent and fireproof structure when the business warrants. By the construction of light, inexpensive tie lines one substation may be arranged to temporarily supply the territory of another, and by the construction of a ring system many miles of expensive transmission line may be replaced by a much lighter class of construction, which will answer all purposes for many years.

In the greater part of California the conditions are ideal for long pole spacing. High winds seldom occur and sleet is unheard of, but it is not uncommon to see a line consisting of three wires ranging in size from No. 2 to No. 8 supported by poles spaced from 120 ft. to 150 ft. apart. However, on new lines, the fallacy of this mode of construction is apparently being realized, and much of the new work looks different. In one case the writer has seen a pole spacing of over 500 ft. in use on light lines, 40-ft. poles being used, which made a very nice appearing and businesslike line. Due to the less number of poles used, better poles, cross-arms and insulators may be indulged in. Other details may be treated in a similar manner.

Description of Typical System.

The writer has been connected for several years with probably the only hydro-electric power project that depends almost entirely on pumped irrigation for a market, approximately 70 per cent of the power generated being used for this purpose, the balance of the power being used for the ordinary commercial purposes in towns and settlements within the territory served, and for the operation of one interurban railway. The entire territory, however, is supported by the agricultural and horticultural products, and, therefore, the system is believed to be almost as nearly an exclusive power pumping system as can be imagined. The actual conditions obtaining on this system should apply closely to conditions which may be expected in other similar projects.

Territory—The territory of the company referred to comprises approximately 1,050 square miles in Tulare and Kern counties, California, being a strip of country about 50 miles long north and south, and 22 miles wide. The only available gravity waters for irrigation are the waters of the Kaweah and Tule rivers, all of which have been long ago appropriated. This gravity water irrigates about 90,000 acres of land and the balance of the territory, or approximately 560,000 acres, must depend entirely on the ground waters for irrigation before they can be made to produce other than grain or pasturage. The average annual rainfall for the territory is about 10 in., and the soil and climate are admirably adapted for the production of all kinds of high-class products. The territory may be for convenience divided into two sections, the citrus belt comprising approximately 200,000 acres of land, and what may be termed the valley portion. In estimating the power requirements it is considered that approximately half of the land in the citrus belt will be planted to products requiring approximately half as much water as the citrus fruits.

Load Characteristics and Power Required for Pumping.

The load curve, Fig. 3, together with the connected load, Fig. 2, will show better than any individual examples the amount of power which is required for a large territory with varying water levels ranging from a few feet to 90 ft., and with lifts above the surface at the wells varying from two or three feet to several hundred feet, there being approximately 18,000 acres of land under pumped irrigation at present.

It is estimated that one horsepower used in the ordinary way during the respective irrigation seasons will irrigate an average of five acres of citrus fruits and 10 acres of other products in the citrus belt, and 16 acres of deciduous fruits, alfalfa, etc., in the valley section.

The following table was compiled from observation at typical pumping plants on the system. In the table the letters at the head of the columns signify as follows:

A. No. of acres of oranges.
B. Average age of orange grove.
C. No. of acres of vines.
D. No. of acres of alfalfa.
E. Horsepower capacity of motor.
F. Horsepower tested.
G. Depth of water during pumping season.
H. Height water is raised above surface of ground at well.
I. Total head.
J. Acres per installed horsepower.
K. Estimated depth of water available over land if operated continuously during pumping period based on 50 per cent plant efficiency.

Plant	A	B	C	D	E	F	G	H	I	J	K
1	30	3	...	...	5	5	86	4	90	6	2.9
2	40	3	...	...	5	3.0	66	4	70	8	1.8
3	54	15	...	...	12	12.1	50	5	55	4.5	6.3
4	50	3	...	...	7.5	5.2	45	5	50	6.7	4.2
5	16	13	...	...	5	4.7	87	3	90	3.2	5.1
6	20	13	...	...	5	4.5	65	5	70	4.0	5.7
7	22	12	...	...	5	4.7	65	5	70	4.4	5.1
8	10	10	...	...	2	2.4	66	4	70	5.0	4.5
9	48	11	...	...	10	9.1	70	5	75	4.8	4.4
10	40	5	...	...	5	4.6	..	..	80	8.0	2.3
11	33	3	...	...	15	12.9	30	100	130	2.2	6.2
12	16	7.5	...	...	10	10	20	100	120	1.6	8.2
13	110	2	...	...	27.5	27.6	40	5	45	4.0	8.8
14	70	3	...	...	15	15	80	..	80	4.6	4.2
15	35	6	...	...	10	7.8	40	..	40	3.5	8.8
16	135	5	100	...	85	69	20	80	100	2.7	4.6
17	66	3	...	...	10	9.7	40	..	40	6.6	5.8
18	111	2	...	...	15	15.8	27	5	32	7.4	7.1
19	140	7	...	...	50	50	60	90	150	2.8	3.6
20	145	7	...	...	50	32.8	60	87	147	2.9	2.4
21	..	..	30	...	15	12.8	28	2	30	2.0	18.8
22	120	10	80	...	47.5	40.1	50	..	50	4.2	6.3
23	..	..	74	...	15	16.2	35	5	40	5	7.2
24	..	..	...	240	10	7.0	0	8	8	24	3.9
25	..	..	...	160	5	5.6	0	16	16	32	3.5
26	..	..	...	260	15	19.2	16	5	21	17.2	5.5

The above table might be extended and averaged to show the horsepower and water required for the supply of various products and for the requirements of orange groves of different ages, but there are so many variable elements entering into each case that any such figures, even if based on an average of every plant on the system, would be, in the writer's opinion, practically worthless. In the case of the high lift

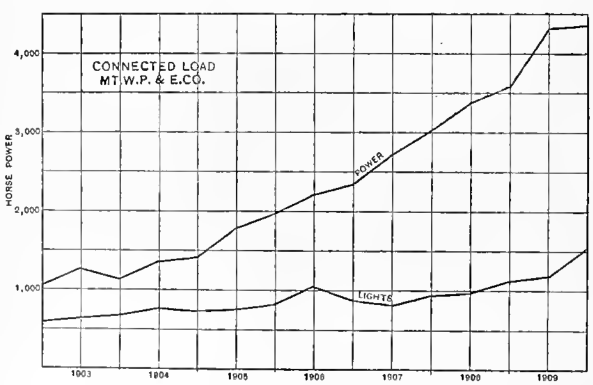


Fig 2.

plants water is usually taken from the main pipe at different levels, but, as the current is charged for at the maximum demand rate and as the pumps are designed for the highest head, only the high head is taken into consideration.

Fig. 2 shows the increase of connected load on the system from 1903 to 1909, inclusive, for power and lights. This curve does not show the railroad load, which is 600 kw. and was connected in February, 1908, and operates at a load factor of approximately 30 per cent throughout the year. Of the total connected power load at the end of 1909, there was 3,776.75 h.p. used for the pumping of water, leaving 573.25 h.p. for commercial power purposes. This applies to all motors over ½ h.p., sizes under this being included in lighting.

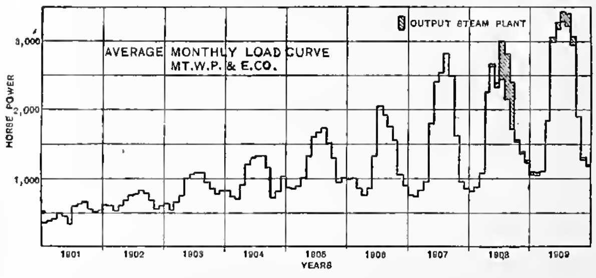


Fig. 3.

Fig. 3 shows the average monthly load curve at the generating stations for 1901 to 1909, inclusive. The shaded portion of this curve represents the load on the auxiliary steam plant, made necessary in 1908 by the disabling of one generator in No. 1 power house and an extremely low water period of the rivers; and in 1909 the steam plant floated on the line until the Tule river plant was completed late in the season, the other power stations being fully loaded.

Fig. 4 shows the load curve for the maximum demand during the years 1907, 1908 and 1909. It will be noted that the maximum demand at the power stations is very much less than the connected load, regardless of transmission losses, although the pumping load is considered extremely steady during the irrigation period, the pumping plants operating 24

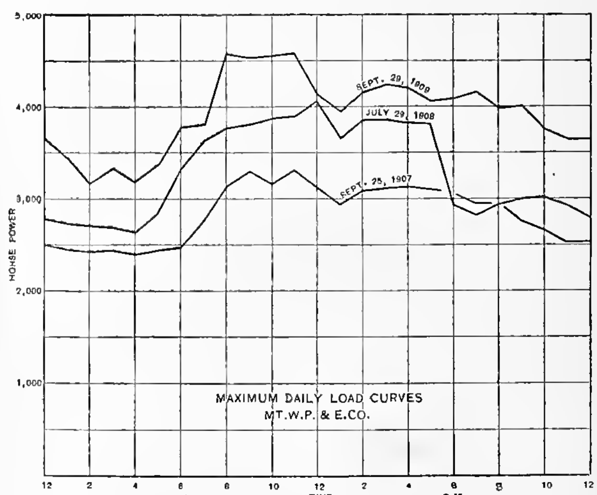


Fig. 4.

hours per day at as near the full capacity of the motor as possible. The lighting load has no appreciable effect on the generating stations during the time of maximum demand, as it is balanced by a certain amount of power used only during the daylight hours.

Fig. 5 shows the load factor of the system, and this also clearly points out an important condition

to be considered in an enterprise of this character, as it is comparatively low. This curve shows that a large amount of power is available for market during the winter and spring months, and with such market ob-

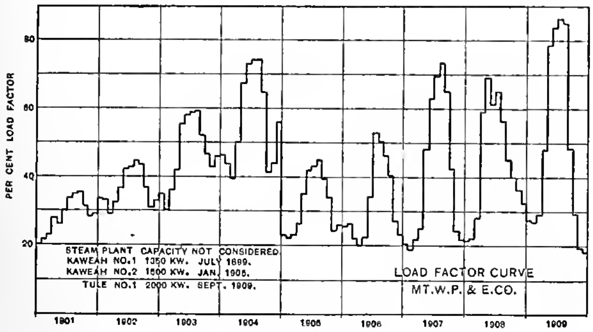


Fig. 5.

tainable, the capacity of the generating stations could be greatly increased, as the flow of the rivers is greatest at this time.

Fig. 6 shows the characteristic flow of the streams during a very dry season, and is a combined curve of the Tule and Kaweah rivers. All of the rivers flowing into the San Joaquin valley have the same general characteristics, and a comparison of the load curve and this curve of stream flow shows the time of heavy load during the period of low water, and the generating plant must, therefore, be designed for the minimum flow of the stream unless suitable storage reservoirs are available. These reservoir sites are available

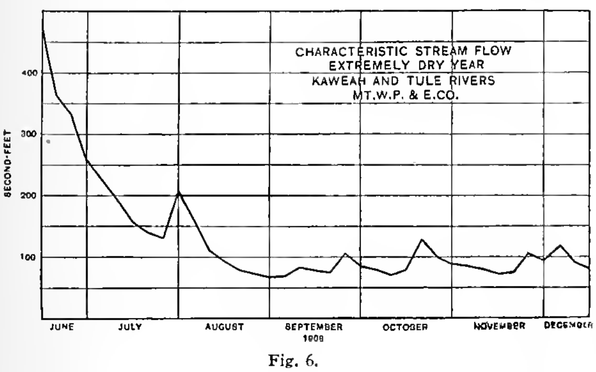


Fig. 6.

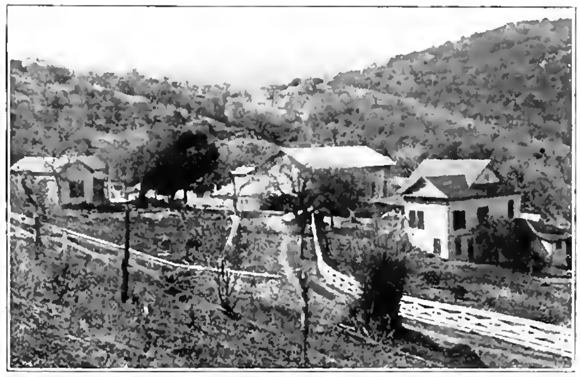
on some of the streams feeding the valley, but are scarce and expensive to develop, and the plants are designed for the minimum flow.

In connection with the load factor curve, it is to be noted that when the load factor reaches approximately 50 per cent it is necessary to construct an additional plant.

Generating Stations.

The generating stations consist at the present time of three hydro-electric power plants having an aggregate capacity of 4,850 kw. and one turbo-generator steam auxiliary plant having a capacity of 1,000 kw. Two of the water-power plants are on the Kaweah river and one on the Tule river, the steam auxiliary being in Visalia, the principal town on the system. The fourth water-power plant, which will have a capacity of 3,000 kw., will also be on the Kaweah river.

Power house No. 1 was the first constructed, and diverts the waters of the east fork of the Kaweah river through six miles of redwood flume. The plant was constructed in 1899, and the flume is today perfectly sound and will last at least 10 years longer before it will require replacement. The static head obtained is 1,310 ft. and the generators are driven by overhung wheels on the generator shaft. The equipment consists of three units of 450 kw. each, two



No. 1 Power House and Grounds.

belt-driven exciters and four 500-kw. transformers, one being a spare transformer. The transformers are oil-insulated and were designed to be self-cooled, but additional cooling is obtained by pumping the oil through coils on which water is sprayed. The transformers are located in individual compartments entirely separate from the power house, as are also the lightning arresters and high-tension switches.

Regulation is manual, controlling stands being situated in front of the switchboard, two of which operate deflectors which regulate the amount of water

Section of No. 1 Flume.

applied to the wheels by deflecting the stream, and one of which regulates the water supply to the third machine by a needle nozzle. At the penstock a regulating reservoir in the form of a large flume has been constructed, having a capacity of 25,000 cu. ft. The main function of this reservoir is to smooth out the daily variation of stream flow, as, due to the method of regulation at the power house, no great economy of water can be practiced, although the needle nozzle

allows the regulation of water to some extent. Since the other plants have been constructed, however, no regulation is done at No. 1, which simply takes a certain load and holds it.

Plant No. 2 was constructed during 1904 and put into operation in January, 1905. The water for this plant is diverted from the main Kaweah river and is conducted to the penstock through 15 flumes aggregating 0.87 mile, and 3.1 miles of ditch. The flumes are all redwood and the ditch is concrete lined, the ditch construction being used where the slopes will permit, the flumes being constructed on the rough broken ground and to cross ravines. A concrete lined penstock reservoir is excavated in the side of the hill having a capacity of 75,000 cu. ft. The static head is 360 ft. and the power house equipment consists of three units of 500 kw. capacity, each direct connected to high-head turbines regulated by Lombard governors. Two turbine-driven exciters are installed, which are hand regulated. Seven 350-kw. step-up transformers are installed in compartments outside of the power house, one being in reserve. The transformers are cooled in the same manner as those at No. 1 by circulating the oil.

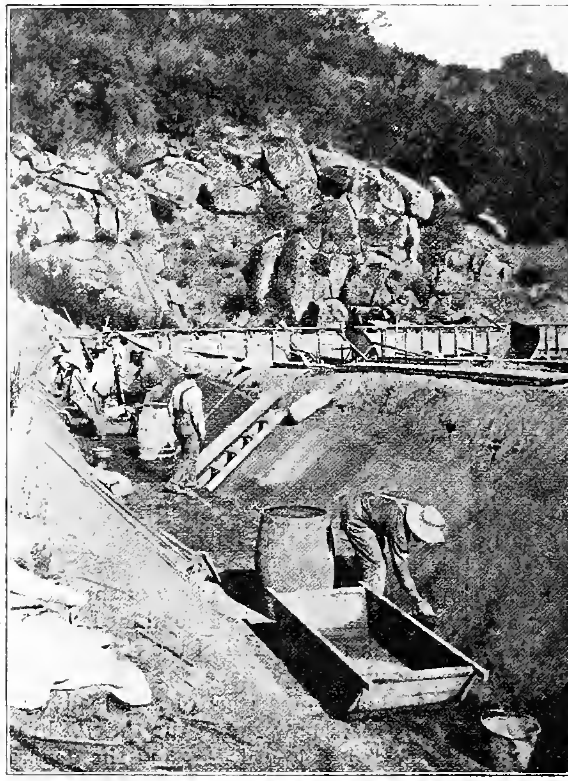
The No. 3 Kaweah plant, on which construction is just started, will divert water from the main Kaweah river, which after passing through a conduit 10 miles long, will discharge just above the intake of No. 2, thereby using the water twice. The static head of this plant will be 1,960 ft.

The transformers at Nos. 1 and 2 are arranged on trucks so that they may be easily run into the power house under the crane for repairs, etc., if necessary. In No. 1 individual tracks are run from each transformer, and in No. 2 a transfer truck is run on the track in front of the transformer compartments, so a transformer may be pushed out on to the transfer truck and taken to a short piece of track entering the power house. The switching gear in both stations is arranged so that the spare transformer may be immediately cut in in place of any other transformer.

The buildings at both Nos. 1 and 2 are constructed of corrugated iron on wood frame; foundations, floors and transformer compartments being constructed of concrete. The corrugated iron structure is, for all practical purposes, ample, as the climatic conditions are most favorable, and a protection from rain is about the only requirement necessary. These buildings are, however, cold in winter and hot in summer, and would not be considered strictly permanent or fireproof.

The third, or Tule river plant, was constructed in 1908 and 1909, and started operation in September, 1909. The water is diverted just above the junction of two forks of the river, there being two diverting dams and headworks from which short flumes lead to a point at approximately the junction of the river and join. The water is conducted to the penstock through 4.5 miles of pine flume, 2.06 miles of concrete lined ditch and 880 ft. of inverted siphon pipe, the siphon working under a 5-ft. head and having its lowest point 120 ft. below the conduit grade. This siphon was used to cross a long gulch.

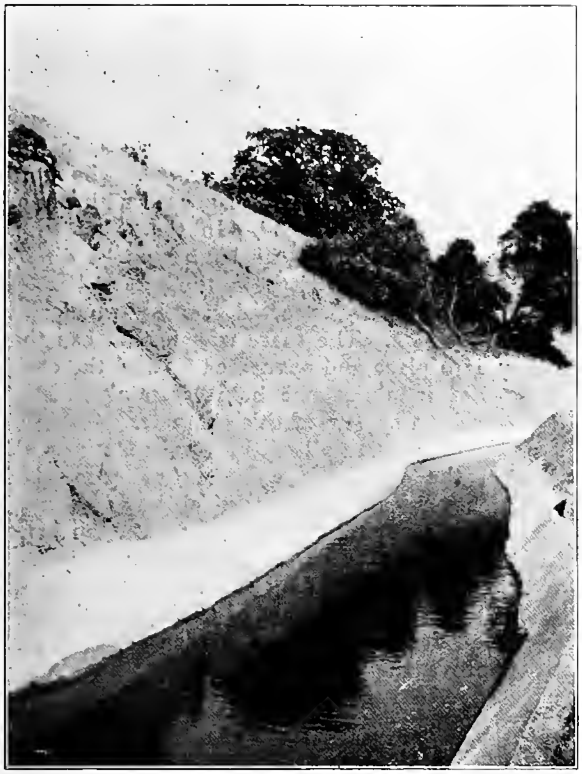
The ditch is lined with concrete and excavated well into the mountain, very little reliance being



Ditch and Flume at Tule Junction.

placed on the filled bank, the water level being only 6 in. above the natural level of the downhill slope. The ditch is 4½ ft. wide and 3 ft. deep, the sides sloping 1 to 1. It is lined with concrete 2½ in. thick, over

Section of Concrete Ditch for Tule Plant



Tule Ditch.

Pumping Plant at Young Grove, at Exeter.

Small Irrigating Reservoir near Lindsay Heights.

which ½ in. of cement plaster is applied. A small amount of alum was mixed with both the concrete and the plaster, which renders the lining practically water tight. Due to the steep slope of the mountain side and the size and depth of the ditch, the sloping of the upper bank to a slope of 1 to 1 required considerable excavation. However, the finished product is a most permanent piece of construction. The flume is of the standard bent and stringer construction, the bents being placed 16 ft. apart, and a strip of burlap saturated with an asphaltum compound is placed under the battens for waterproofing.

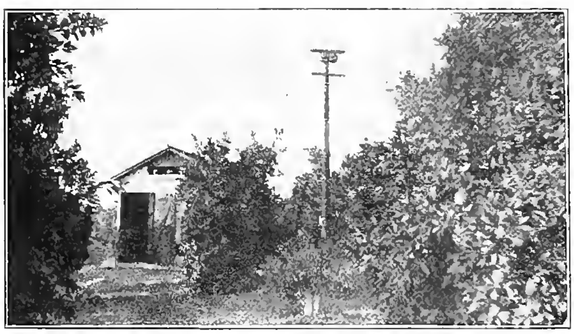
At the penstock a regulating reservoir is excavated in the side of the mountain. A small portion of the upper end is 5 ft. deeper than the balance of the reservoir and is used as a sand-trap. The reservoir is 12 ft. deep, 350 ft. long and of an irregular shape, varying from 12 to 125 ft. in width, following the contour of the hill. The side slope is ½ to 1, and it is lined with 8 in. of concrete and ½ in. of plaster. A concrete wall at the end separates it from the penstock.

The reservoir has a capacity of 175,000 cu. ft., which will operate the plant 1¾ hours at normal load. Therefore, in the case of a break in the flume, sufficient time will be available to start the steam auxiliary plant without interruption of service. The reservoir also has sufficient capacity to regulate the daily fluctuation of stream flow during the low water period, so that the highest use may be made of the water. The static head is 1,135 ft., and the whole plant is designed with a view of ultimately doubling the present capacity.

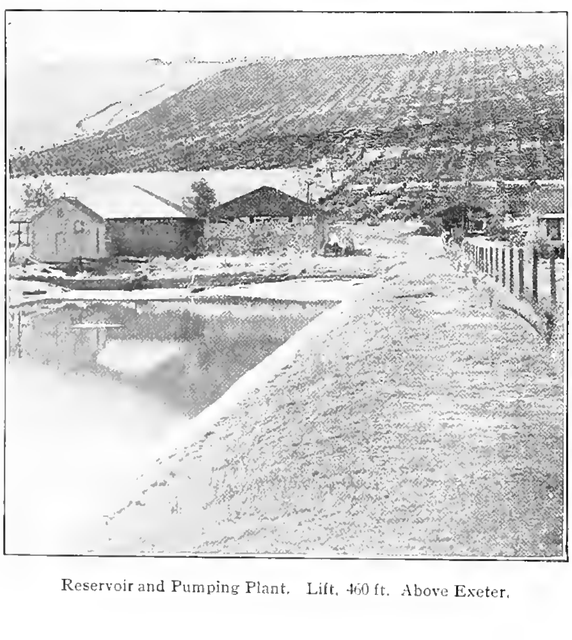
The power house equipment consists of two 1,000-kw. units with overhung wheels, Lombard governors, directly actuating needle nozzles, an auxiliary nozzle being provided which automatically opens in the event of the main needle nozzle closing too quickly and ramming the pressure pipe. These auxiliary nozzles, when opened, close at a predetermined speed regulated by the dashpot principle. This arrangement allows the most economical use of the water. Two exciters, each of sufficient capacity for both generators are installed, one being driven by a water wheel and one by an induction motor. Seven 400-kw. water-cooled transformers are placed in the transformer room on one side of the power house, one transformer being held in reserve. Lightning arresters and high-tension switches are in a separate building.

The power house building and arrangement differ from the other plants in several respects. The power house is constructed of ferroinclave on a steel frame, the ferroinclave being plastered on each side with 1½ in. of cement plaster, therefore making a reinforced concrete roof and sides 3 in. thick. A partition of the same thickness divides the generating room from the transformer room and a similar partition divides the transformer room into two compartments, fireproof doors completing the separation. The switch house is constructed of the same material, and both buildings have metal window casings and wired glass windows, no wood being used in the construction. The above may seem inconsistent after the statement that the other power house structures were practically sufficient, and this would be the case were it not for the fact that the transformers which present a certain fire

Lindsay Sub-Station.



Pumping Plant and Grove.



Reservoir and Pumping Plant. Lift, 460 ft. Above Exeter.

hazard are placed in the power house building. Also the company has passed the pioneer period, and can, consequently, afford a little more permanent construction.

The switching gear and wiring has been greatly simplified by connecting the transformers in two banks, the spare one not being connected. The transformer "railway system" is also dispensed with, simple rollers being provided instead. In the event of an accident to one transformer its bank may be disconnected, the leads removed from the affected transformer, water pipes disconnected and the transformer skidded to one side. The spare transformer can then be skidded into place and connected up and the entire job performed in about one hour, certainly a short enough time for a system of this character.

In connection with all of the power stations, the question of the operator's comfort has been given proper attention. From a practical business point of view, this is a paying investment, as a much better class of men can be procured. Comfortable cottages are provided, the surrounding grounds are cultivated and a small ice plant is a part of the standard equipment. A few fruit trees and a garden will not only greatly improve the looks of the property, but will also greatly reduce the boarding house expense.

Transmission System.

As shown in Fig. 1, the transmission system is in the form of a figure 8 or a double ring. In this way current is available at both sides of any substation, thereby giving all of the advantages of duplicate lines. The main transmission line from power houses Nos. 1 and 2 feed in at the northeast corner of the system and the line from the Tule river plant feeds in at the center of the system. The steam auxiliary is in the northern ring and can consequently feed both ways. The old transmission lines have wires spaced 36 in., the sawed redwood poles being spaced 120 ft. apart. The new transmission lines in the valley consist of a double circuit, the 34,000-volt lines being placed on one side of the pole and a 6,600-volt distributing line on the other side. The circuits form equilateral triangles, the apex of which point downward; the wires are spaced 36 in. apart on each circuit. The main line from the Tule river plant consists of one circuit, the poles being of cedar 35 and 40 ft. in height and spaced 300 ft. apart. On all new lines a pole spacing of from 300 to 420 ft. is used, with 35- and 40-ft. poles, depending on the character of the country.

The current is distributed from 12 substations situated in the various towns and settlements, and the transmission and distribution systems are laid out to provide for additional substations as the load increases. The substation construction varies, all but one having started in the same way, namely, as a cheap wood or galvanized iron building with the most simple switching apparatus, and, as the substation grows in importance, substantial brick buildings are constructed with more or less elaborate switching gear, storerooms and offices.

The power is distributed at 6,600 volts and 2,200 volts, two-phase, the first distributing being at 2,200 volts; 6,600 volts eventually proved more satisfactory

on the power circuits. The city lighting systems distribute at 2,200 volts, two-phase, with the exception of two new systems, where three-phase has been adopted. There are 246 miles of 6,600-volt line, 53 miles of 2,200-volt line and 28 miles of lighting circuits of 2,200 volts and about the same length of low-voltage line with a connected load of 1,190 kw. of lighting transformers. The consumer supplies the secondary transformers for power supply and the power is measured on the primary side of these transformers.

Investment Value of a Power Irrigation Project.

The application of a hydro-electric system exclusively for the furnishing of power for pumped irrigation from an investment point of view is not of the get-rich-quick variety. The investor who wishes to receive immediate results on his money should not enter into any such scheme, unless the power company owns the lands to be put under irrigation, when the project develops into a real estate transaction, the power part being insignificant. Where the project is confined wholly to a power proposition, it should be gone into only by the most conservative investors or developers and pioneers who are content to bide their time and be satisfied for many years without dividends, but with the increased value of their investment. The power company must indirectly meet the opposition of other irrigation districts, and the large government projects, as well as the opposition of gasoline engines and other power, and the charges for service must be as low as possible.

The final results must be arranged for years before they are obtained and everything shaped to this end. A desire to hasten the marketing of the power may set some precedent which would be most difficult to overcome, and the failure to provide for emergencies may undo the work of years and completely demoralize a system. An overloaded system is to be particularly guarded against, as too much valuable produce depends entirely on the service, and any damage to the producer may completely stop development and stifle the entire community. The power company, therefore, has a very large moral responsibility to face, which is not to be lightly considered.

A single-stroke gas engine for automobiles, motor boats and aeroplanes has been invented by George Enderby and Henry Johnson of Harrogate, England, who claim that the ideal and popular engine under this system would probably consist of three cylinders, which would have only 7 working parts, and taking the speed of crank shaft to be 1,000 revolutions per minute, there would be 6,000 working strokes during the same period. Comparing it with a 4-cylinder of the present or Otto type, running at the same speed, the number of explosions or working strokes would be 2,000 during the same period, so that with the new engine even with one cylinder less the torque is three times as continuous; but taking the fact that the new engine is absolutely devoid of valves with springs, the speed of it is considerably greater and the turning movement is more like that of a turbine than an internal-combustion engine with piston and connecting rods. This new type of 3-cylinder engine would be equal to a 12-cylinder engine of existing type.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER VII.

(Continued.)

Meter Troubles

Some of the most common troubles encountered in connection with watthour meters may be summarized as follows:

Excessive Vibration—If a meter is placed in such a position as to be subject to excessive vibration, creeping often results; vibration is also severe on the lower bearing. This trouble can in many cases be remedied by placing rubber washers between the meter and the wall upon which it is supported; in severe cases a spring suspended board is recommended. Wherever possible, meters should be installed in places that are entirely free from vibration or jarring effects. It is not unusual to find meters installed near doors which are often closed and opened, and especially is this bad practice where the wall or partition is of light construction.

Humming and Rattling of Induction Meters—This trouble is usually due to loose laminations in the magnetic circuit, and can be remedied by tightening them up. Rattling may also be due to a vibration of the disc and shaft in very loosely aligned meters, which trouble can usually be removed by carefully examining, locating and tightening the exact parts that may be loose. Excessive humming is sometimes caused by the potential winding being loose on the potential pole, which trouble can be easily remedied by driving small, flat wooden wedges between the insulating sleeve (upon which the coil is mounted) and the core.

Humming is not an inherent phenomenon of the induction meter, and trouble from this source can always be traced to some simple mechanical defect. It sometimes happens that the wall upon which the meter is mounted acts as a "sounding board," thus magnifying the humming of the meter. This can be corrected by the use of rubber washers as above mentioned for excessive vibration. It is best, however, to remove the meter to a place that will not be subject to such trouble.

Weakening of the Retarding Magnets—Magnets, after having been in service for some time, may become weak, due to the "aging" of the steel; this should not occur, however, if they have been thoroughly and properly treated before leaving the factory. Weakening due to aging is a very serious defect and shows the lack of proper methods or care in their manufacture. Such trouble should be guarded against in the selection of meters. The retarding magnets may also be weakened by the effects of powerful stray fields, or by heavy short circuits on the "load" side of the meter.

The retarding magnets should never be moved closer than one-quarter of an inch to the periphery of the disc, because if they are there will be a leakage of magnetic flux around the disc, from pole to pole of the magnets, thereby decreasing the number of lines of force that actually cut the disc. This of course will have the same effect as the weakening of

the magnets, and will cause the meter to run fast. Magnets that will not produce the necessary retarding effect when moved within a quarter of an inch of the edge of the disc are too weak and they should be discarded.

Sometimes it is found necessary to place iron shields around the damping system of meters which are not already provided with such a protection against stray fields, and when this is done the meter should be re-calibrated, since the proximity of the iron shield may allow a leakage of flux which would result in the same trouble as placing the magnets too near the periphery of the disc.

Bent Shafts and Buckled Discs—These troubles may be due to one of three causes; by abuse, by the effects of short circuits of a severe nature, or to faulty manufacture; the only remedy is to install new parts.

Creeping—Creeping may be due to "over-compensation" of the light load adjustment, vibration, high voltage, or a combination of any or all of these effects, or in commutating meters by the external resistance being short-circuited. Some types of induction meters have two small holes punched in their discs, the holes being diametrically opposite. When the part of the disc which has the hole in it comes under the influence of the electrical element, the torque is thereby sufficiently decreased to allow the disc to stand in that position when there is no current flowing in the series coils. This method very effectually prevents "creeping," but it does not affect the accuracy of the meter.

Creeping in the commutating type of meter can be very effectively eliminated by clamping over the edge of the disc a small piece of U-shaped soft iron wire; when the piece of wire comes under the influence of the retarding magnet the attraction of the magnet tends to hold the disc in that particular position, therefore preventing creeping on no load. The size of the clip can be so selected that it will prevent creeping, but which will not prevent the meter from starting on light loads nor affect the light load accuracy.

A modification of the last named method consists in attaching a piece of iron wire to the shaft of the meter in such a manner that its free end extends out radially and comes under the influence of the retarding magnets; the effect of the wire can be varied by bending it so that its free end comes closer to or further from the magnets.

Defective Jewels—The simplest and probably the easiest way of detecting roughness or defectiveness in the jewel bearing is to take the point of a sharp needle and gently "feel" the entire surface of the jewel. A fracture or any roughness can thus be detected. In this connection it might be stated that one of the best materials for cleaning the jewels and pivots is the pith from a cornstalk. After the jewel and pivot have been thoroughly cleaned, the pivot should be wiped with a clean rag which has been moistened with a high grade of watch oil, but under no conditions should it be flooded with oil.

Changing Position of Commutator on Shaft—If the commutator is shifted from its correct position on the shaft it will cause the meter to run slow; if it is shifted 90 degrees the meter will stop, and if shifted more than 90 degrees the meter will run backward.

Backward Rotation of Commutating Meters on Light Load—It may sometimes be found that the commutator meter will run in a reverse direction on light loads, while on heavier loads it will run in the proper direction. Such a trouble will be found due to a reversed connection of the compensating field, so that instead of helping the main field out, its action is differential. Care should therefore be taken to see that the compensating field is properly connected.

Open-Circuited Armatures—The current in entering the commutator divides at each brush and flows through the armature in two multiple paths of equal resistance; if one of these paths is opened, it will therefore be seen that the equivalent resistance of the armature will be doubled, which will cause the meter to run at about half speed. The same result may be accomplished by using an ordinary candle-power lamp and moving the connection from one bar to the other; the lamp will not light until after the defective coil has been passed.

The defective coil can very easily be located with a voltmeter. Apply the normal voltage to the two brushes and with one of the voltmeter leads permanently attached to one brush, move the other lead over the commutator from bar to bar, during which operation no deflection will be indicated on the voltmeter until the defective coil is reached, unless the movable voltmeter terminal happens to be passed over that half of the armature in which there are no open-circuits.

Friction in Upper Bearing—It sometimes happens that the upper bearing is pressed down too tightly against the upper end of the shaft, thereby causing excessive friction which will result in the meter running slow on light loads; this trouble is easily remedied by loosening the binding screw and raising the bearing slightly.

Friction in the Registering Mechanism—If the registering mechanism is allowed to accumulate dirt and grease it will develop undue friction; care should therefore be taken to see that the registers are kept in good, clean condition.

Dirt on Meter Disc—Small pieces of trash or dirt on the meter disc will, if they come in contact with the retarding magnets, or the stationary element, act as a brake on the meter.

(To be continued.)

The present high price of rubber is claimed to be largely artificial and due to the speculation which is rampant, particularly in London. The demand now exceeds the supply, but it is believed that as the new trees which are being so extensively planted and which require from five to seven years before producing, come into bearing, their product will glut the market. The 80,000 tons which the world is expected to produce in 1910 will hardly care for the needs of the makers of insulated cables and of rubber tires, and at the present rate of increase, prices will soon become commercially prohibitive.

DISCUSSION

RECONSTRUCTION.

The Editor—Sir: C. L. Cory's paper on the "Public Service Corporation" and the attendant discussion as published in the Journal of Electricity, Power and Gas brings up some interesting points on the subject of reconstruction which seem difficult to apply in the following case:

A locomotive in yard transportation service recently came up for a general overhauling. Of course we had been charging in to the overhead the cost for minor repairs, such as repairs to the cushions the engine driver sits on, new springs for the throttle lever, an occasional new brake shoe, and new grate bars now and then. It is my opinion that these charges should go into the overhead.

Now, in this general overhauling the engine received repairs such as new tires, rebore cylinders, new pistons, new piston rings, new journal brasses, new rod brasses, etc., with a general, thorough overhauling. The estimated cost for this work was: Direct labor, $360; direct material, $70; total direct charges (no indirect included), $430.

If we were far advanced in the science and practice of cost keeping we would probably have a depreciation account, and each year we would charge off from the capital value of the machine a certain amount which we would take up in a depreciation account, so that when the time came for a big overhauling of the machine we would pay for it from this depreciation account, charging the depreciation account with a proper proportion of overhead charges, and then we would set a new depreciation rate on the machine, taking it up in the capital account at its depreciated value before repairs plus this cost of repairs. However, we have no depreciation account. It, therefore, is my idea that the charges for this general overhauling should be sunk in the overhead, because I think the customer of the plant has to pay a percentage to cover this reconstruction work, as well as replacements, and as we have no direct allowance for depreciation we simply have to soak it into this overhead charge.

Please note that it is my opinion that the charge run into the overhead should be the $430 direct labor and material, with no figure for the overhead, because, although the expenditure of this amount, if applied to output, would bring a greater return than the sum of the labor and the direct material, still, considering the relation of the plant as a whole to outside interests, there is only a small amount of overhead and it really should make no difference how we charge it. On the other hand, as I have stated above, it is my opinion that if we had a depreciation account it should be credited and the capital account debited by the sum of the direct labor, direct material and overhead charges for the job.

All of the foregoing covers an example, I think, of reconstruction. In the case of minor repairs, which are not at all in the nature of renewals, I think the charges could go into the overhead. I think that the replacement of a worn-out and scrapped locomotive should come out of the depreciation account ordinarily, but where we have no depreciation account, should come out of the overhead.

The actual course followed was to charge the cost of these repairs plus the overhead to a specific order issued under an appropriation which is taken up really as output.

ENGINEER.

[It would seem from this that the entire cost of the general overhauling of the locomotive, including all labor and material, estimated at $430, should under any conditions of operation or methods of accounting be charged absolutely to repairs and not to depreciation. Repair such a locomotive as much as you like; you simply keep it in operating condition, but there will certainly come a time when the entire locomotive must be replaced by a new one of more recent design, and unless your general overhauling and repairs increase materially the capacity of the locomotive all the expense of your overhauling is simply upkeep. Depreciation cannot be prevented by repairs, although they may postpone the inevitable march to the scrap pile.

Depreciation should never be charged against the capital account, but such depreciation should be met by a sinking fund, which may be drawn upon when needed to purchase or pay for absolutely new apparatus of the same capacity, and for the same use to replace obsolete and depreciated equipment, which must be abandoned as unfit for service because unsuited either in type, size or design by an advanced state of the art in manufacture or operation.

Depreciation should come annually from the cost of operation, but because a piece of apparatus has depreciated the money originally required to purchase it has not been reduced or diminished, but your sinking fund covering depreciation must, whenever called upon, be used to make your total equipment represent honestly the same capital investment originally put into your new equipment, which is not to be discarded.

The overhauling of such a locomotive is not reconstruction, but is really the repair of the machine. New tubes in the boilers should come from repairs and not from reconstruction. Of course if one chooses they may divide up repairs into different items, which might include such reconstruction.

Such repairs may very properly be charged to maintenance and operation, but in addition to all charges for maintenance and operation your accounts certainly should provide for a still further item which in general should include depreciation, obsolescence, extraordinary contingencies, and should be understood as to include everything which experience shows should be provided, and to keep the installation originally representing the total capital account in such a condition as it may honestly and fully represent such capital account at all times. Any reduction in the value of the plant must be made up from your depreciation account, and at any time the total capital account must be not less than the physical valuation at any time plus the sinking fund which is set aside to cover depreciation, obsolescence, etc.—Editor.]

DETERMINING COEFFICIENTS OF MODERN HIGH PRESSURE FRANCIS TURBINES.[1]

BY MARIO DORNIG.

With the steadily increasing utilization of water powers the opportunity has repeatedly arisen to build units of large capacity, i. e., for correspondingly large quantities of water even under high head. In such cases Pelton wheels with vertical shaft and several symmetrically arranged nozzles or such with several wheel runners on a common horizontal shaft do not form a solution that is either low in cost or convenient for the arrangement of the plant. Compared with such types of construction a high pressure Francis turbine has equally high efficiency, permits of equally good governing, requires considerably less space, and its arrangement is more compact and more easily accessible. On the other hand, the high turning speed resulting with this system means no difficulty to the builders of modern turbo-generators and permits at the same time a reduction in the weight of flywheel mass with the high peripheral speed, or rather to make better use of it by storing larger quantities of energy.

Several important plants with turbines of that type are enumerated in Table I. There are further to be mentioned the plants of Hamilton-Niagara, Bussoleno, Landeck-Pians, Lend-Gastein, Reutte (near Fuessen), Kubelwerk-St. Gall, and several others. The latter, however, cannot be really called Francis-slow-runners. Also for the Walchensee competition some manufacturers have proposed turbine types for a head of about 650 feet.

TABLE I.

	H	Q	N	n	
1. Jaice (Ganz & Co.)	245	46	1000	300	single
2. Rauris-Kitzloch (Escher Wyss & Co.)	427	50	2000	450	double
3. Centerville (Allis-Chalmers Co.)	585	198	9700	400	single
4. Schaffhausen (Escher Wyss & Co.)	520	22	1000	1000	double
5. Albulawerk-Zurich (Escher Wyss & Co.)	492	67	3000	600	double

H = Head in feet. Q = Quantity of water in second feet.
N = Horsepower. n = Revolutions per minute.

We want now to bring together the determining basic factors for the calculation of such slow-running turbines and consider their characteristic determining values separately.

As in the calcuation of high-speed-Francis-turbines, the discharge diameter is one of the most important dimensions; with slow-speed-turbines the entrance width (b) of the runner plays the most important part, since for mechanical reasons this must not drop below an absolutely fixed minimum (7/8 to 1 1/8 in.).

If we take

$$1+m=\frac{a+s}{a}=1+\frac{s}{a},$$

(a) meaning the width of discharge of the distributor and (s) the thickness of the vane, we get:

$$b=Q\,\frac{(1+m)}{c\,D\pi\sin\alpha},\text{ and substituting } u=\frac{D\pi n}{60},$$

$$b=\frac{Q\,(1+m)n}{c\,u\,60\sin\alpha}.$$

[1]Translation by courtesy of Heinrich Homberger, Consulting Engineer, Pacific Building, San Francisco.

Since, however, $u\,c\cos\alpha=\epsilon g H$, we get

$$b\,tg\,\alpha=\frac{1+m}{60\,\epsilon g}\times\frac{Qn}{H}\text{ or}$$

$$b\,tg\,\alpha=k_1\,\frac{Qn}{H},\qquad(1)$$

wherein $k_1=\dfrac{1+m}{60\,\epsilon g}$ is a constant.

Introducing the value N from the relation $62.4\,Q\,H\,\eta=550\,N$, equation (1) becomes

$$b\,tg\,\alpha=\frac{(1+m)}{60\,\epsilon g}\times\frac{550}{\eta}\times\frac{1}{62.4}\times\frac{Nn}{H^2},$$ which, by combining the constant values as k_2 may be written:

$$b\,tg\,\alpha=k_2\frac{Nn}{H^2}.\qquad(2)$$

If we now take m between .1 and 0, or on an average $m=.05$ and $\epsilon=.84$ we get

$$b\,tg\,\alpha=.000648\,\frac{Qn}{H^2},\qquad(1a)$$

where all dimensions are given in feet.

If we further assume $\eta=.75$ we get

$$b\,tg\,\alpha=.007615\,\frac{Nn}{H^2}.\qquad(2a)$$

With multiple turbines (b) has to be made equal the sum of the widths of the single runners; in case of a double runner with common distributor, however, (b) may become smaller than the sum of the widths of separate runners.

In case the head is very high it is necessary to increase the turning speed correspondingly; one can compromise on this, however, with large units to some extent by making α as small as possible—down to 15 degrees and less—but it must be taken into consideration that the value

$$a=\frac{\pi}{1+m}\times\frac{D}{Z_e}\times\sin\alpha\qquad(3)$$

must not become too small. Entirely wrong would it be in any event to try to reduce the value (b) by increasing the relative thickness of the vanes (m), because this would reduce the efficiency. It is rather advisable to shape the guide-vanes in such way that the value (m) may be taken practically to equal zero. Since (b) is independent of (D), consequently also of ρ, $k=\dfrac{u}{c}$ and β, these values have to be determined with respect to other circumstances.

To give an exact insight into this a diagram is given of the values of $\dfrac{w_1}{c}$, $\dfrac{u_1}{c}$, $\dfrac{c_1}{c}$, (wherein c equals $\sqrt{2\epsilon g H}$) and of ρ as found for different values of β.

$w_1^2+u_1^2+c_1^2-2u_1 c_1\cos\alpha$, and, with reference to the relation $2\,u_1 c_1\cos\alpha=c^2$ we get

$$w_1^2=u_1^2+\frac{c^4}{4\,u^2\cos^2\alpha}-c^2$$

$$\text{or}\quad\left(\frac{w_1}{c}\right)^2=\left(\frac{u_1}{c}\right)^2+\frac{1}{\left(2\dfrac{u_1}{c}\cos\alpha\right)^2}-1\qquad(4)$$

$\dfrac{w_1}{c}$ reaches its smallest value when $\left(\dfrac{u_1}{c}\right)^2=\dfrac{1}{2\cos\alpha}$

i. e., when

$$u_1^2 = \frac{c^2}{2\cos\alpha} \times \frac{2u_1 c_1 \cos\alpha}{2\cos\alpha} \text{ or when}$$

$$u_1 = c_1 \qquad \beta = 90° - \frac{\alpha}{2}.$$

The curves of Fig. 1 show the interdependence of $\frac{w_1}{c}$ and $\frac{u_1}{c}$ with different values of α.

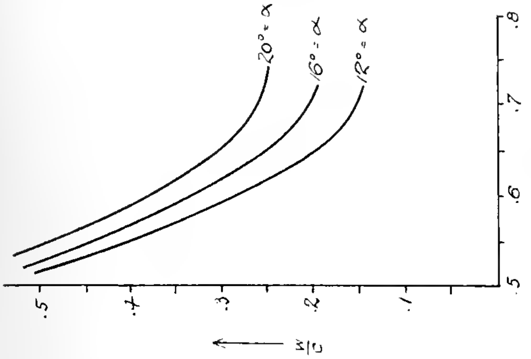


Fig. 1.

A simple calculation gives: for limit turbines

$$\beta = 180° - 2\alpha \qquad \frac{w_1}{c} = \frac{1}{2\cos\alpha}$$

$$\text{for } \beta = 90° \qquad \frac{w_1}{c} = \frac{tg\,\alpha}{\sqrt{2}}$$

$$\text{for } \beta = 90° - \frac{\alpha}{2} \qquad \frac{w_1}{c} = \sqrt{2}\,\frac{\sin\frac{\alpha}{2}}{\sqrt{\cos\alpha}},$$

or tabulated

α °	$\frac{w}{c}L$	$\frac{w}{c}90°$	$\frac{w}{c}$ min.
20	.533	.257	.254
18	.527	.229	.227
16	.521	.202	.201
14	.516	.176	.175
12	.511	.150	.149

There is further:

$$\frac{u_1{}^L}{c} = \frac{1}{2\cos\alpha}; \quad \frac{u_1{}^{90°}}{c} = \frac{1}{\sqrt{2}}; \quad \frac{u_1{}^{90°-\frac{\alpha}{2}}}{c} = \frac{1}{\sqrt{2\cos\alpha}},$$

or, for $\frac{u_1}{c}$:

α °	$\beta = 180° - \frac{\alpha}{2}$	$\beta = 90°$	$\beta = 90° - \frac{\alpha}{2}$
20	.533	.707	.732
18	.527	.707	.726
16	.521	.707	.722
14	.516	.707	.719
12	.511	.707	.717

and for $\beta = 180° - 2\alpha$, $\frac{c_1}{c} = 1$,

$$\text{for } \beta = 90°, \qquad \frac{c_1}{c} = \frac{1}{\cos\alpha\,\sqrt{2}},$$

$$\text{for } \beta = 90° - \frac{\alpha}{2} \quad \frac{c_1}{c} = \frac{1}{\sqrt{2\cos\alpha}};$$

herefrom the values of $\frac{c_1}{c}$ may be calculated by using the following table:

α °	$\beta = 90°$	$\beta = 90° - \alpha$
20	.754	.732
18	.744	.726
16	.737	.722
14	.730	.719
12	.724	.717

There is further:

$$\rho_{90} = 1 - \frac{1}{2\cos^2\alpha}; \qquad \rho_{90-\frac{\alpha}{2}} = 1 - \frac{1}{2\cos\alpha},$$

$$\text{or } \rho_{90} > \rho_{90-\frac{\alpha}{2}} < .5.$$

This shows that if β is reduced or $\frac{u}{c}$ and D are increased, c and therewith the eddy and friction losses in the distributor, consequently the corrosion resulting from same becomes smaller; much larger, however, is the decrease of $\frac{w}{c}$ with increasing $\frac{u}{c}$; it is a well known fact, by the way, that sharply curved vanes give poor efficiencies with heavily changing load. On the other hand, the hydraulic friction of the runner body, the loss in the gap and the axial thrust, if such prevails at all, become larger with increasing β, i e. with increasing ρ and D.

The loss in the gap may be assumed to be proportional to the diameter of the runner and the square root of the pressure in the gap, since

$$H_2 = \epsilon H - \frac{c_1^2}{2g} = \epsilon H \left(1 - \frac{2\epsilon g H}{4u_1^2\cos^2\alpha}\right)$$

$$= \epsilon H \left(1 - 2\epsilon g H \times \frac{3600}{4\pi^2 n^2 D^2 \cos^2\alpha}\right)$$

and, if H and n are given

$$\text{Loss in gap} = \sqrt{AD^2 - B}$$

If the axial thrust is not entirely eliminated by using a double runner or a suitable balancing arrangement, this may be similarly made proportional to the reaction pressure and D^2, i. e.:

$$\text{Axial thrust} = A_1 D^2 - B_1$$

where the coefficients B and B_1 have to answer the same conditions

$$A\,D^2_L - B = 0, \quad A_1 D^2_L - B_1 = 0$$

for a limit-turbine of the diameter D_L. The strain of the runner by centrifugal force, however, is with

$$\beta = 90° - \frac{\alpha}{2}$$

almost twice as high as with a limit-turbine, and all dimensions and weights become larger with the larger diameter of the runner; the force required for shifting the guide vanes and the flywheel momentum of the revolving parts are also larger.

The last mentioned disadvantages originating from B=about 90°, although not inconsiderable, are not decisive when compared with the advantages gained, since with this type of high pressure turbines the losses due to shock and eddies caused by the water entering into the runner, the friction losses in the runner itself and the wear of the runner vanes play a much more important part.

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Copper's cost, like its mines, has not reached bottom.

California produces an electric iron for the laundry and electric iron for the foundry.

Railway terminal electrification terminates traffic troubles.

Waterpower stock and bonds are booming.

The season for hunting alternators is never closed.

Aluminum is soaring, not in price but in airships.

Rubber is inflated in price as well as in tires.

Irrigation bonds inundate the market.

Celluloid insulation is greatly affected by the heat.

Waterpower Sites

"There are valuable water power sites through all the public land States." So said President Taft in his memorable "conservation" message, so say the muck-raking proclaimers of a waterpower trust, and so think most of the people who have been grievously misled by one of the greatest press bureaus that ever added its burden of franked mail to the postal deficit. It requires but one fact to negative the ninety and nine claims as to the tremendous value of waterpower sites—without development they are as worthless as so many sites for wind power.

Here in the West we know of no such entity as a waterpower site. The term is a misnomer which has insidiously crept into our language because of its kinship to that well recognized piece of property, a dam site. A dam may be used to produce a head of water from which power may be generated after the necessary ditches have been dug, pipe lines laid, buildings erected and machinery installed to make it a power plant.

But all this takes money and courage. Withdraw the capital and the site becomes as worthless as the day the water first started to run down the newly-raised hills. Capital is now so intimidated by the action of certain well-meaning, but ill-advised, enthusiasts, that it hesitates to assume the risk of such development when there are so many safe channels for investment. This hesitancy cannot but retard the growth of the country tributary and thus hurt our national prosperity. The hue and cry of a few zealots has assumed the dignity of a political issue and we are threatened with a policy of conservation that will prove more disastrous to the people's welfare than the most careless excess in utilizing Nature's bounties. A waterpower site is the direct antithesis to the proverbial poet in that it is made, not born. A location may have every advantage of topography and hydrography, and yet be so far from a market that an otherwise less desirable site is selected. This selection is more often governed by commercial considerations than by natural conditions. The mere combination of geologic relief and favorable meteorology gives a dam site no more value as a power plant site than does a pauper's unpatented invention constitute a commercial success. In other words, it is a mistake to consider a dam site a waterpower site. In rhetoric this process of naming a thing by one of its attributes is known as metonymy, but in business it is worse than foolishness to imagine that an undeveloped location is valuable as a waterpower site without the aid of capital.

CURRENT COMMENT

Examination for assistant engineer is announced by the United States Civil Service Commission on July 13-14, 1910, to fill vacancies as they may occur in the Reclamation Service in the positions of assistant engineer at salaries of $1500 per annum and upward, and junior engineer at salaries of $900 and upward.

A. I. E. E. officers elected at the meeting in New York City on May 17, 1910, were: President, Dugald C. Jackson; Vice-Presidents, P. H. Thomas, H. W. Buck, Morgan Brooks; Managers, H. W. Barnes Jr., C. E. Scribner, W. S. Rugg, R. G. Black; Treasurer, Geo. A. Hamilton; Secretary, Ralph W. Pope. The constitutional amendment relative to the manner of choosing the secretary did not carry.

Non-inflammable celluloid is again announced, this time in a paper by Prof. Gautier before the French Academy of Sciences. Celluloid is an excellent electrical insulation except for its dangerous liability to fire and should this new process, which substitutes an ether silicate for the alcohol and ether ordinarily used as a solvent for the camphor and nitrocellulose, prove successful, it has many commercial applications.

A wireless system in Brazil is provided in a contract signed between the Lloyd Brazileiro, the subsidized line of steamships serving Brazilian ports and New York, and the United Wireless Telegraph Company of New York for equipping 21 ships of the Lloyd line and eight stations along the Brazalian coast. One land station is to be at Rio Grande do Sul, one at Santos, three in and near Rio de Janeiro, one at Bahia, one at Pernambuco and one at Para. The system will afford communication between Rio de Janeiro and all the Lloyd fleet all the time, except the New York service when ships are out of range. Most of the passenger ships between Europe and South America and two ships running between New York and the eastern coast of South America are already equipped with wireless apparatus, and the proposed system will give a wireless service in the South Atlantic similar to that in the North Atlantic.

Deaths from electric shocks in Switzerland, which is bountifully supplied with electric power, have averaged less than 35 during the past five years. Of the 36 victims of last year, 28 were engaged in electrical callings and 5 were building mechanics, killed while working by coming in contact with live conductors, principally on the roofs of buildings. Of the remaining 3 victims, one was a servant, another a factory hand and the third a child. An analysis made of the accidents showed that the greater number was due to lack of precaution on the part of the victims, particularly in the case of the electrical employes. The servant attached a wire to a kite line to lengthen it and the wire came into contact with a 6,000-volt conductor. The child climbed the pole of a high-tension line and touched a conductor, death in this case being probably due to the fall.

The electric conductivity of soils has been found by O. E. Davis to increase almost directly as the moisture percentage, increases depending in part on the character of the soil, humus decreasing the conductivity and alkali increasing it.

A new tungsten lamp, the continuous wire type as distinguished from the ordinary series of separate filaments was described in a paper by C. F. Scott at the recent National Electric Light Association convention. A single 30-inch filament, elastically mounted as a spiral spring to each of the leading-in wires is loosely held by intermediate supports. This gives a filament not only of greater mechanical strength but also of more uniform resistance.

An electric ozonizer is a device that produces ozone by means of high tension electric discharges. Ozone is an unstable oxygen compound containing three instead of two atoms to the molecule, the third atom being particularly active in attacking germs, and consequently valuable in purifying polluted air and water. It has a peculiar penetrating odor familiar to all workers around electric apparatus but its commercial possibilities have been but recently applied. For use in sterilizing water, otherwise undrinkable because of organic or sewage content, it may ultimately become a desirable central station load.

Electrolytic separation of oil from condenser water is detailed in a paper read by Prof. H. M. Goodwin and Mr. Risdale Ellis at the recent Pittsburgh meeting of the American Electrochemical Society. The oil particles become negatively charged and migrate to the anode. With iron electrodes and a dilute sodium carbonate electrolyte basic ferrous carbonate is also precipitated at the anode carrying down the oil particles migrating there. But as the oil may be separated just as well by shaking the emulsion with precipitated basic ferrous carbonate the electrolytic method seems to offer no great advantage.

The right of condemnation for the electric transmission lines is sustained in a decision of the Court of Appeals rendered this week in California. The award of $50 per tower given W. A. Frederick, a property-owner of Pleasanton, Cal., by a lower court had been appealed upon the ground that the defendant company, the Tuolumne Water Power Company, had no right of condemnation and that the damages awarded were inadequate. The Appellate Court, in its decision, holds that an electric transmission line has the right of condemnation and that the sum of $50 per tower is a substantial consideration. The court, furthermore, holds that the choice of route lies with the plaintiff company and that, as long as the company is shown to be acting in good faith, the landowner cannot object if the company select any particular location for its line. This decision affects all of the interior counties of California where electrical transmission lines are being strung, and also San Mateo county, where much work of this nature has been undertaken.

PERSONALS.

Robert Catton of the Catton-Niell Co., Ltd., of Honolulu, is at San Francisco.

H. A. Kennedy, an electrical engineer of New York, is a recent San Francisco arrival.

Russell B. Cressman of Pass & Seymour of Solway, New York, is visiting the Pacific Coast.

E. N. Sanderson of Saudersou & Porter has returned to New York after a tour of the Northwest.

J. W. White, of the San Francisco office of the Fort Wayne Electric Works, has returned from a northern trip.

John W. McDowell of the Manhattan Electrical Supply Company of New York, was at Los Angeles last week.

Leon M. Hall, of Hall, Demarest & Co., has been making an electrical engineering investigation near Red Bluff.

F. A. Cressey Jr., manager of the Modesto Light & Water Company, has returned to Modesto after visiting San Francisco.

G. W. Bacon, of Ford, Bacon & Davis of New York City, has returned East after spending some time at the company's San Francisco office.

H. F. Gronan has succeeded Frank C. Kelsey, resigned, as engineer in charge of the Nisqually water power project of the city of Tacoma, Wash.

A. H. Lamm recently became associated with the Sacramento Valley Power Company's hydroelectric plant near Shingletown, Shasta County, California.

M. M. O'Shaughnessy is again at his San Francisco office, after spending several weeks in San Diego and vicinity in connection with water works extensions.

Harry E. Swett, formerly chief engineer of the Metropolis Bank Building, has accepted a similar position in the new Mechanics' Library Building on Post street.

D. M. Coughlin has taken charge of the new business department of the Spokane Falls Gas Company of Spokane, Wash., having resigned a like position with the Easton Gas & Electric Co. of Easton, Pa.

C. G. Pyle, Los Angeles representative of the Standard Underground Cable Company, will spend the first two weeks of June in a horseback trip through the mountains along the line of the Los Angeles aqueduct.

John Furness who was for many years chief engineer of the Palace Hotel, is now chief engineer of the Pacific Fruit Express Company's large pre-cooling and ice plant in connection with the Southern Pacific Company's yards at Roseville, Cal.

Martin Kubierschky, vice-president of the United Railways Investment Company, of New Jersey, recently arrived from New York. He has been looking over the properties of the United Railroads of San Francisco, in which his company has the holding interest.

Wynn Meredith, manager of Sanderson & Porter's Pacific Coast office, has gone to Victoria, B. C., and will remain in the Northwest for the next month or two. He will supervise the construction of the Jordan River development on Vancouver Island for the British Columbia Electric Railway Company.

F. O. Dolson, erecting engineer, with the Pelton Water Wheel Company, has returned from La Grange, Cal., where he installed an additional Pelton-Francis turbine direct connected to a 450 k.w. generator for the La Grange Water & Power Co. Current is furnished for Turlock, Modesto and La Grange. The company operates one of the largest gold dredges in the State near La Grange.

BANQUET TO SOUTHERN CALIFORNIA EDISON OFFICIALS.

A banquet was tendered the officials of the Edison Electric Company of Los Angeles by the citizens of Long Beach on May 25th in celebration of the company's decision to erect its new 40,000-h.p. steam generating plant at Long Beach. The dining-room of the Hotel Virginia was elaborately decorated, 25,000 small colored electric lights being used and four electrical fountains. At the entrance to the banquet hall, the guests were confronted with a revolving electric wheel which at ten-minute intervals stopped, all the lights going out but those which spelled in large letters the word "Edison." The Pacific Electric Company furnished a special car free to carry the Los Angeles guests to the Hotel Virginia and return. The Edison men who were present were: W. A. Brackenridge, vice-president and general manager; R. H. Ballard, secretary and assistant general manager; S. M. Kennedy, general agent; B. F. Pearson, general superintendent; J. A. Lighthipe, electrical engineer; W. L. Percey, treasurer; E. W. Sax, auditor; John Otto, purchasing agent; C. H. Coulter, assistant purchasing agent; H. W. Dennis, construction engineer; W. C. Sterling, general storekeeper; H. W. Burkhart, gas engineer; A. W. Childs, assistant general agent; R. E. Cunningham, assistant superintendent; F. B. Lewis, assistant superintendent; W. L. Boxall, power contract agent; William Dieterle, power development agent; H. C. Stinchfield, chief surgeon; R. J. C. Wood, engineer; C. H. Pierson, advertising agent; A. E. Morphy, assistant secretary; W. J. Wallace, right of way agent; M. D. Mann Jr., engineer; E. H. Warner, engineer; J. N. Pyster, engineer; C. S. Walton, Los Angeles district agent.

TRADE NOTES.

The Pacific States Electric Company will open a branch house at 90-92 Seventh street, Portland, Ore., early in June.

The Ransome Concrete Company announce the removal of their main offices from the Crocker Building to the Mechanics' Institute Building, 57 Post street, San Francisco.

The Western branch of the Cutter Electrical & Manufacturing Company has been moved to 98 Jackson boulevard, Chicago, under the management of H. F. Darby Jr.

The Pacific Gas and Electric Company has acquired the light and water power holding of E. D. M. Lehe of Dixon. It is the purpose of the purchasers to develop the plants formerly owned by Lehe and extend the lighting and water pumping services to the rural districts surrounding the towns in which plants have been secured. Lehe owned the lighting plants and water supply stations at Wheatland, Lincoln, Davis, Roseville, Cordelia, Elmira, Winters, Dixon, Rio Vista and Benicia.

The General Electric Company reports that the Sierra & San Francisco Power Company has ordered, for the North Beach power station of the United Railroads, an additional 9,000-kw. Curtis turbine generator with condenser base. The new 60-cycle machine is rated as follows: A. T. B. 10, 9,000-kw. maximum capacity, 720 r.p.m., 11,000 v. When this has been installed the present 5,000-kw., 25-cycle Curtis turbine set in the station will be remodeled by the substitution of a 9,000-kw. (max.) generator.

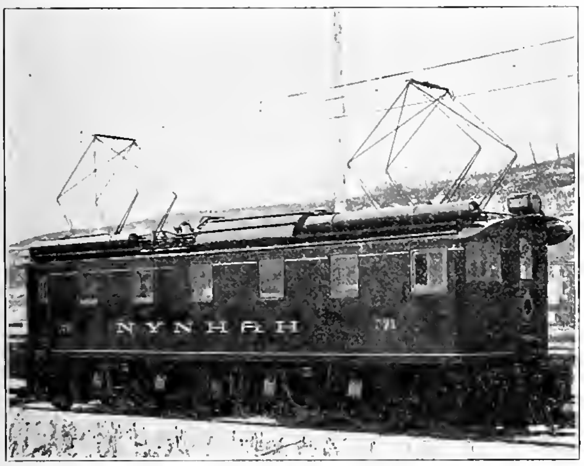
W. J. Krase, constructing engineer of the Pelton Water Wheel Company, has gone to Metaline, Wash., to install several water wheels for the Inland Portland Cement Company. This concern is affiliated with the Lehigh Portland Cement Company and will use a large amount of current for the operation of its own factory. The Sylvester Company of Spokane are the erecting engineers. The wheels are of about 2,500-h.p., operating at 360 r.p.m. under a head of 450 ft., and each is direct connected to a Westinghouse generator. There will be two Pelton and Westinghouse 125-kw. exciter sets operating at 600 r.p.m. The water of Sullivan Creek will be used in the wheels and discharged into the Pen'd Oreille River.

INDUSTRIAL

ELECTRIC LOCOMOTIVE PERFORMS WELL IN TESTS.

The Westinghouse Electric & Manufacturing Co. completed recently the 150-ton locomotive for use on the electrified section of the New York, New Haven & Hartford Railroad between Stamford and New York City. The entire electrical equipment, including the spring drive of the motors, is the design of the Westinghouse company, while the mechanical parts were designed by the engineers of the Baldwin Locomotive Works and the New Haven Railroad Company.

The specifications required that the locomotive be able to haul a 1,500-ton freight train at a speed of 35 miles an hour on level track, where the train resistance is not over six pounds per ton. They also required that the locomotive be capable of hauling an 800-ton passenger train at a speed of 45 miles an hour. This capacity would enable it to haul an 800-ton limited train from the Grand Central Station, New York City, to New Haven, a distance of 73 miles, with no intermediate stops, in one hour and fifty-five minutes; or to haul an 800-ton express train the same distance in two hours and twelve minutes, with an allowance of five minutes for stops; or to haul a 350-ton local train in two hours and forty-five minutes with an average stop of forty-five seconds.



150-ton Westinghouse Electric Locomotive.

That the locomotive is an unqualified success has been demonstrated by frequent tests made under severe operating conditions. Besides proving itself in other ways, it has hauled 37 loaded cars, a heavy freight engine and a caboose from New Rochelle to Stamford, a distance of 18 miles, in 27 minutes. Although this run was made in a drizzling rain that froze as fast as it fell and made the tracks very slippery, the engine attained a speed of 49 miles an hour. During some tests made at the works of the Westinghouse company at East Pittsburg, Pa., the locomotive started and accelerated a 2,100-ton freight train both on level track and on an upgrade of 0.3 per cent on a 3-degree curve. A train corresponding to the 800-ton passenger train was accelerated at a rate of about 0.4 miles per hour per second and quickly reached the required speed. For hauling trains the new locomotive has about twice the capacity of any one of the locomotives already in use on the New Haven Railroad. Each motor has a one-hour rating of about 373 h.p. and a continuous rating of approximately 310 h.p. The tests made have shown that the locomotive has a good margin over the specifications. By its performances it has shown conclusively that it can amply fulfill the service conditions.

The design of the trucks and running gear of the locomotive is unique. The truck frames are connected by an intermediate drawbar. One truck has only a rotative motion about its center pin, while the other has a fore and aft, as well as a rotative motion, in order to compensate for the angular positions of the trucks and drawbar when the locomotive is traversing a curve. The tractive force is transmitted through the truck frames and drawbar instead of through the main frame. Each truck has two pairs of driving wheels and a single pair of leading wheels. The wheel loads are equalized as in steam locomotive practice. To assist in reducing shocks and keeping the two trucks in alignment, chafing castings and spring buffers are interposed between the truck frames under the center of the locomotive. The weight of the cab, instead of being carried on the center pin, is carried on friction plates at the ends of the truck. The weight is applied through springs which have a considerable latitude of motion to allow for variation in the track without changing materially the distribution of weight on the ends of the truck. The plan of running-gear and cab support adopted for this locomotive prevents any periodic vibration or "nosing," minimizes shocks on the truck and road bed and insures easy riding. As the rigid wheel base is only 7 ft. for each truck, the locomotive is extremely flexible and easy on the track at curves and special work.

The electrical equipment, which was built and mounted by the Westinghouse Electric & Manufacturing Co., comprises four single-phase geared motors, together with the auxiliary apparatus necessary for their operation from the 11,000-volt, alternating current, or 600-volt, direct current circuits of the electrified sections of the New Haven and the New York Central railroads, respectively. The motors are of the same general electrical design as those in use on the present New Haven locomotives, the main differences being in the mechanical details and general arrangement.

Each motor is rigidly mounted on the truck frame and directly above a quill surrounding the driving axle, to which it is geared. The motors project into the cab and the floor above them is raised. This method of mounting the motors on the truck frame gives a high center of gravity and prevents the transmission of strains and shocks from the track and road bed to the motors.

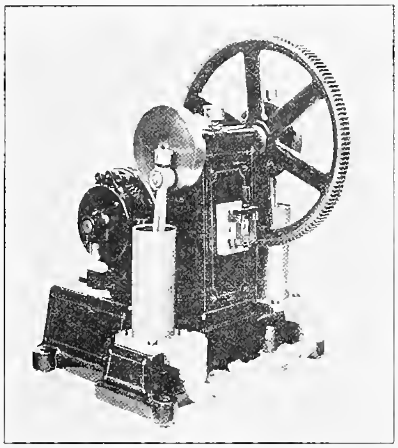
An air blast transformer is provided for lowering the trolley line voltage to that required by the motors. The control apparatus is of the Westinghouse electro-pneumatic type. When operating on alternating current all four motors are connected in multiple and the control is obtained by changing the connections to various voltage taps on the main transformer. On direct current the motors are first grouped all in series, and then two in series and two in parallel in combination with various resistance steps. Provision is made for cutting out any one of the four motors singly on either alternating current or direct current. A master controller and brake valve are located in each end of the cab so that the locomotives can be operated from either end, and the system of control is such that two or more locomotives can be coupled together and operated from one master controller. The speed control is extremely flexible.

Two pneumatically-operated pantograph trolleys are provided for collecting current from the 11,000-volt alternating-current line. Pneumatically-operated third-rail shoes are used to collect current on the direct-current third-rail section.

AUTOMATIC VACUUM PUMP.

The Keuffel & Esser Co. of San Francisco and New York have recently placed upon the market an improved automatic vacuum pump and air compressor. The pump is intended for maintaining vacuum for blue printing frames, compressed air for bicycles, automobiles and experimental purposes.

The pump may be converted into a vacuum or pressure pump by simply reversing the valve discs. The controlling mechanism is securely enclosed in the bearing pedestal and is such that it can be readily cut out and the pump operated at will, and, if desired for continuous use as a pressure pump, the vacuum controlling mechanism may be readily changed to automatically operate the pump as a compressor, which may be readily adjusted to maintain any desired pressure.



Automatic Vacuum Pump.

The pump shown here is adjusted to maintain a vacuum of from 10 to 20 in. The operation of the pump is as follows: The pump is connected to a vacuum tank and on closing the switch the pump starts up and runs until 20 in. vacuum is obtained, when the pump automatically stops and remains at rest until the vacuum drops to 10 in., which again starts the pump, continuing until 20 in. again is reached and then stops.

Any pressure or vacuum within the capacity of the pump may be automatically obtained. The pump and automatic controlling apparatus was designed by L. St. D. Roylance, electrical and mechanical engineer of San Francisco, for the Keuffel & Esser Co.

NEW CATALOGUES.

A pamphlet on exhaust fans has recently been published by the Crocker-Wheeler Company of Ampere, N. J., as Bulletin No. 124.

Bulletin No. 124 from the Electric Storage Battery Company deals with the "Exide" battery in emergency service in central stations.

"The Story of the Storage Battery" and the intimate connection of the Electric Storage Battery Company therewith is well told in an interesting booklet from this company.

"How to Light Your Home by Electricity" with gas engine, generator and storage battery is illustrated and described in a book recently issued by the Electric Storage Battery Company.

Bulletin 119 on large engine type d.c. generators, recently issued by the Crocker-Wheeler Company of Ampere, N. J., contains much information useful to any central station man.

Bulletin 121 from the Crocker-Wheeler Company of Ampere, N. J., describes small direct current engine-type generators. It is handsomely illustrated throughout with half-tone engravings.

HOUSE ORGANS DISCUSSED BY THE TECHNICAL PUBLICITY ASSOCIATION.

The thirty-seventh regular monthly dinner and meeting of the Technical Publicity Association was held on Thursday evening, May 12th, in the galleries of the National Arts Club, 14 Gramercy Park, New York. The subject of "House Organs" was the topic for the evening and proved extremely interesting to all present. In conformity with a recent decision, the chair was turned over to the chairman of the special program committee for the evening, Mr. S. M. Wilson, who assumed the toastmaster's role for the balance of the evening.

In introducing the first speaker of the evening, Mr. C. R. Lippman, advertising manager of the Genuine Bangor Slate Company, Mr. Wilson referred to the March, 1907, "House Organ" night of the association when six speakers entertained a large audience through a long evening. He said that with 500 house organs in the field and the subject of growing importance and interest the members could expect some real beneficial remarks from the speakers.

Mr. Lippman prefaced his remarks on the "Policies of House Organs" by the statement that there are but 500 house organs in this country although there are almost a million firms doing business, indicating that the house organ is only in its infancy. He classified house organs into six divisions, as follows:

First—House organs issued to salesmen and agents.

Second—House organs for dealers.

Third—House organs going to technical consumers, that is, consumers who do not resell the goods but use them in their own business or else specify them.

Fourth—House organs going to the ultimate consumer.

Fifth—House organs published by retail stores.

Sixth—House organs carrying advertisements.

Mr. Lippmann reviewed more than a hundred specimens of house organs as to their varying nature, make-up and probable effect, and exhibited more than 300 different publications for the education of those present.

The following speaker, Mr. H. S. Snyder, of the Jos. Dixon Crucible Company, delivered an interesting address on "Functions and Advantages of House Organs," which he treated most carefully. Mr. Snyder brought out the essential features which the house organ should possess and how in some ways, it excels other forms of advertising.

Mr. H. M. Wilson, vice-president of the McGraw Publishing Company, New York, read a very able paper entitled "The Attitude of Trade Journals Toward House Organs," in which he expressed the opinion that house organs publishers are infringing on the rights of the trade paper publishers in denying them first hand access to articles for their publications and mentioned other inconsistencies of concerns issuing house organs.

"More Than Half Way" was the title of a paper read by Mr. Clark Schurman of the Dean Hicks Printing Company of Grand Rapids, Mich., in which he urged, in addition to other things, that the advertiser endeavor to study his own proposition more from the buyers' viewpoint than from his own, as is usually the case.

Mr. W. R. Hulbert, in charge of advertising, Goldschmidt Therit Company, New York, speaking to the subject of "Tangible Results from House Organs," read abstracts from numerous letters received from concerns publishing house organs, who testified to the actual results they were able to trace from their publication. A company in Hamilton, O., stated that "one issue of their publication was responsible for $60,000 worth of business in thirty days." The meeting was one of the largest held by the association and, from the intense interest manifested, was a great success.

NEWS NOTES

INCORPORATIONS.

CLE ELUM, WASH.—The Cle Elum Falls Power Company has been incorporated for $1,000,000 by H. J. Manning et al. of Tacoma.

SAN FRANCISCO, CAL.—The Union Water Company of California has been incorporated by W. T. Barnett, C. C. Sullivan, E. T. Zook, A. S. Grain and V. W. Vincent, with a capital stock of $1,000,000.

SAN FRANCISCO, CAL.—The Sierra-San Joaquin Electric Company has been incorporated by Los Angeles capitalists with an authorized capital of $5,000,000 for the development of power on the Tule river in Tulare county, to supply the demand for power in the southern portion of the San Joaquin Valley. A power plant will be located 25 miles from Portervi le, capable of developing 8000-h.p. to supply the Kern and Midway oil fields, including the towns of Taft and Maricopa.

SAN FRANCISCO, CAL.—The Marysville-Colusa Railway Company has filed articles of incorporation. The directors are Charles H. Hammon, Leon de Sabla, Samuel Lilienthal, George E. Springer and Herbert W. Furlong. The authorized capital stock is $1,500,000, of which $30,000 has been subscribed. George E. Springer is secretary of the company. The purpose of the corporation is to build a railroad from Marysville through Yuba City to Colusa, a distance of 30 miles. The new road will be a branch of the Northern Electric Railway.

FINANCIAL.

YACOLT, ORE.—By a vote of 42 to 14 Yacolt voted to bond for the new water system. It will be a gravity system. The source of supply is Big creek falls.

PROVO, UTAH.—Both the proposition for a bond issue of $110,000 for a municipal lighting plant and an issue of $30,000 to increase the waterworks plant carried at the election here last week.

VALE, ORE.—An election will be held for the purpose of voting on the issuance of bonds in the amount of $70,000 to provide funds for the installation of a complete waterworks and sewerage system to cover the entire townsite.

VALE, ORE.—The Council has passed ordinances for an election at which time the voters shall be submitted the question of voting to bond the city in the sum of $75,000 for the construction of a water system at a cost of $45,000 and also a sewer system to cost $30,000, both to cover the entire area within the city limits.

EL PASO, TEX.—An election will be held on June 21st to determine whether or not the city sha'l issue bonds for the purpose of providing waterworks to be owned by the city. The water bond to be in the sum of $375,000, to bear 5 per cent interest per ann"m, payable semi-annually, and to become due and payable in 40 years, subject to redemption at the option of the city after the expiration of 20 years from date.

SAN FRANCISCO, CAL.—The resolution reopening negotiations with the Spring Valley Water Company looking to a purchase of a part of the company's plant by the city has been referred by the public utilities committee to the Board of Public Works. Supervisor Walsh pointed out that the resolution was vague, in that it did not state what part of the Spring Valley's holdings it was purposed to purchase, and the resolution was referred, with the request that what was needed by the city for a water supply be deliminated.

TRANSMISSION.

MALDEN, WASH.—The Malden Supply & Power Company has purchased a power site at the head of Rock lake, where it is expected 2,000 horsepower can be developed.

VICTORIA, B. C.—A. E. Waterhouse of Seattle has applied for a record on the Spreat river of 500 inches, with the intention of erecting a power plant to supply electricity to Port Alberni.

VICTORIA, B. C.—Sealed tenders have been received by the Hon. Minister of Public Works for the construction of a transmission line for the purpose of furnishing electricity for the Hospital for the Insane at Coquitlam.

BAKERSFIELD, CAL.—The Power- Transit & Light Com, pany is preparing to go ahead with the construction work on its Kern river power plant. It is planned to make the plant large enough to answer the demands of a city of 30,000 people.

MOUNTAINHOME, IDAHO.—The Crane Fal's Power & Irrigation Company will begin work immediately on the feed canal and head works of its power plant at Crane falls on the Snake river, 15 miles south of here. The plant wi'l have a capacity of 14,000 horsepower.

GRANTS PASS, ORE.—J. H. Beeman of Gold Hill has announced that the Rogue River Water & Power Company will spend $100,000 developing power this year. Mr. Reed, manager of the company, has announced that the power plant will be built on the Gold Hill Canal Company's property.

PORTLAND, ORE.—The Puget Sound Bridge & Dredging Company, Central building, Seattle, has been awarded the contract for the construction of a masonry dam, 885 feet long and 100 feet high, to cost $1,000,000, across the Clackamas river thirty miles south of Portland for the Portland Railway, Light & Power Company.

ILLUMINATION.

BANCROFT, IDAHO.—Hyrum Call is taking steps to install an electric light plant here.

ETNA, CAL.—W. N. Mullin has presented his plan for a lighting system to the Board of Trustees. A decision will be reached by the Board on or before June 14th.

SHERIDAN, MONT.—O. B. Preston, president of the municipal lighting plant in St. Johns, Mich., will, within four months, install an electric lightiug system here. The power site is on Indian creek.

ARCADIA, CAL.—The City Council passed an ordinance granting Chas. S. S. Forney the right to construct, institute, install, lay and maintain under ground conduits, mains and gas pipes in the city of Arcadia.

LOS ANGELES, CAL.—The City Council has adopted the suggestion of the Board of Public Utilities that the maximum rate for electric current be reduced from 9 to 7 cents per kilowatt hour. The new rate goes into effect on July 1.

SAN FRANCISCO, CAL.—Sealed bids for installing a complete electric light system, including fixtures and sub-station at the Presidio of San Francisco, will be received at the office of the constructing quartermaster at Fort Mason, until 11 a. m., June 15th.

PASO ROBLES, CAL.—An ordinance has been passed granting C. F. Hoffman a franchise to lay gas pipes for the purpose of carrying gas for heat, light and power and to erect poles and wires for transmitting electricity, heat and power along, under, over and upon the public highways in San Miguel.

SAN FRANCISCO, CAL.—The San Francisco Gas & Electric Company has submitted bids for lighting the city's streets and public buildings which on the basis of last year's business would save the city $17,000 for the arc light service and $10,000 on the gas lamps. The schedule proposed by the company has been referred to the committee for recommendation.

MARYSVILLE, CAL.—Manager J. E. Poingdestre of the Marysville district of the Pacific Gas & Electric Company, has received notice from headquarters that his territory will hereafter include Wheatland and Lincoln. Heretofore he has had supervision of the company's business in Marysville, Sutter county, and the northern portion of Yuba county. Material is arriving for the new gas-holder of 100,000 feet capacity, to be installed in connection with the improvements intended in the service for Marysville and Yuba City.

LOS ANGELES, CAL.—The Board of Supervisors will receive sealed bids up to 2 p. m. June 20th for a franchise to lay down and for a period of 50 years to maintain a system of gas pipes in all public roads and highways in the following section: 15, 16, 18, 19, 20, 21, 22, 25, 27, 28, 29, 32, 33, 34, 35 and 36, township 1 north, range 13 west; sections 30 and 31 in township 1 north, range 12 west and sections 2, 3, 4, 9 and 10 of township 1 south, range 13 west, S. B. B. M., omitting from above territory all highways within the limits of the city of Glendale.

SAN FRANCISCO, CAL.—The gas and electric systems at Suisun and Fairfield, owned by Leonard Prior, have been purchased by the Pacific Gas & Electric Company. The transfer of the properties will be made June 1. Though these two systems have been owned by Prior, he for some time past has been purchasing his current and gas from the Pacific company and in turn selling the utilities to the citizens of Suisun and Fairfield The transaction eliminates him from his position as middleman, and the Pacific company will sell direct and operate its own plants.

TRANSPORTATION.

LOS ANGELES, CAL.—The City Council passed an ordinance granting to Robert Marsh and John Howze the right to construct and for a period of 21 years to operate and maintain a double track electric railway on Vermont avenue.

ONTARIO, ORE.—Attorney A. N. Soliss, representative of Henry Lewitt, a Spokane capitalist, has made application to the City Council for a street railway franchise in Ontario. It is stated that the new line would connect at Snake River near Nyssa, with the Pierce line to Caldwell.

VALLEJO, CAL.—At a meeting of the directors of the Vallejo & Northern Electric Railway Company it was decided to call a special meeting of the stockholders of the company to be held in this city on July 28, at which time the proposition of increasing the capital stock from $2,500,000 to $10,000,000 will be voted upon.

SAN FRANCISCO, CAL.—The United Railroads Company has paid to Treasurer McDougald $34,274.25, the amount due the city as percentages on the gross receipts of the company for the year 1908. There is still unpaid the amount due for 1909, on which no report has been made by the corporation, but which, it is estimated, will approximate $40,000.

SEATTLE.—John E. Ballaine has secured the right from Louis Brennan, of the British War Office, to use the Brennan monorail in Alaska and will establish a line fifteen miles in length, from mile 29 on the Alaska Northern Railway to the Moose Pass district. The Moran Company, of this city, will construct the cars, and Mr. Brennan will make the gyroscopes.

SACRAMENTO, CAL.—J street from Sixteenth to Thirty-first, will be torn up for about 90 days while an asphaltum pavement is being put down and new rails are being laid by the Sacramento Electric, Gas and Railway Company. The old track is to be entirely torn up and new construction is to be put down. The construction is to be standard. The ties are to be laid on a rock ballast, and the rails are to be of the latest grooved type. They weigh 87 pounds to the yard.

SAN FRANCISCO, CAL.—Construction work on the electric line of the Central California Traction Company between Sacramento and Stockton is going forward rapidly, according to the statement of George W. Peltier, president of the company. Three miles of piling and bridge work across the Cosumnes river and lowlands has been completed. A steam locomotive is being used by construction crews between Brighton and Sheldon. Mr. Peltier said that as soon as the track is completed all the way between Stockton and Sacramento the company will put on trains gradually until a 15-minute service is perfected.

WATERWORKS.

MEDFORD, ORE.—Jacobsen-Bade Company has been awarded the contract for the laying of six-inch water mains and four miles of sewer.

LODI, CAL.—H. H. Henderson, a civil engineer, has been awarded the contract to install the Lodi municipal plant for light, water and sewerage.

CALDWELL, IDA.—The Hartenhower Bros. of this city have been awarded the contract for the city waterworks system for the bid of $59,733.70.

OAKLAND, CAL.—The contract for the extension of the pipe system of the salt water fire-fighting plant has been awarded to Michael Murphy on his bid of $23,353.40.

EL CENTRO, CAL.—Instead of constructing only a temporary water system for summer use, as was proposed, the City Trustees have decided to install a complete municipal water system.

COTTAGE GROVE, ORE.—The City Council has entered into a contract with the American Water & Light Company of Kansas City, Missouri, for the construction of a water system from Layng creek to connect with the present water system, a distance of 18 miles, the price being the amount voted for the purpose, $100,000.

BELLINGHAM, WASH.—The sum of $4,800 or $12 a foot for the 400 feet of main to be laid is given by Acting Engineer William North as the preliminary estimate of the cost of extending the city's intake into deep water in Lake Whatcom. This estimate includes the cost of wood stave pipe, of the intake proper, with its screens and vales, of the piling and cribbing and of all labor, including that of the diver to be hired.

PASADENA, CAL.—Several of the water companies here are considering developing more water, in view of a dry summer. The North Pasadena Company hopes to build another large reservoir nearer the head of its system, to accommodate users higher up and to keep consumers supplied. The Lake Vineyard Company expects to resort to pumps. The Alhambra Company is deepening its wells and expects to go to the foothills to develop a greater supply.

MILLVILLE, CAL.—The Appellate Court has reversed Judge Head of the Shasta County Superior Court, saying in effect, the Northern Light and Power Company cannot condemn farmers riparian rights. The Appellate Court says, in effect, that that public service corporation can do it by law. Old Cow Creek at its low stage in summer carries, roughly estimated, 3000 inches of water. The farmers living along the stream have irrigation ditches that divert 1000 inches of water, roughly estimated, to their land. This leaves 2000 inches in the creek. These 2000 inches are a riparian water right. The Appellate Court has said that the Northern Light & Power Company may take this 2000 inches and devote it to a public use.

JOURNAL OF ELECTRICITY

POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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FOR INDEX TO ADVERTISEMENTS SEE PAGE EIGHT

JOURNAL OF ELECTRICITY
POWER AND GAS
Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXIV SAN FRANCISCO, JUNE 11, 1910. NUMBER 24

THE N. A. S. E. LOS ANGELES CONVENTION

BY HARRY D. SAVILLE.

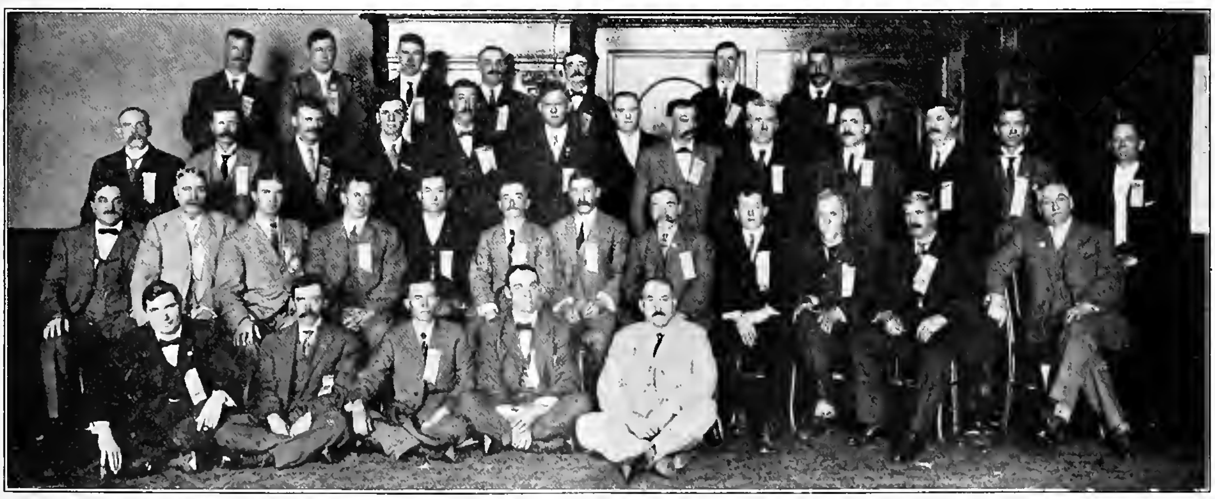
The seventh annual convention of the California State Association of the National Association of Stationary Engineers convened in the city of Los Angeles on May 24, and continued to hold sessions throughout the week. Delegates were present from the associations throughout California and the meetings were presided over by J. M. Pyster, president, who acted as a delegate from the association at Santa Barbara. Among the first matters to be brought to the attention of the convention was the president's annual report which contained, among other things, the following recommendations:

"That a State Educational Committee be hereafter composed of one member from each association in the State, they to have full charge of the educational work, the latter to be preferably based upon the reports of the National Educational Committee.

"That the State Association take necessary steps to encourage and secure the much needed standardization of all machinery used in the generating of power.

"That special attention be given to the problem of attendance at meetings of the associations, so that members would feel that they could not afford to be absent, but when unavoidably detained that they have lost something of value."

Aside from the routine business incident to such a convention, the matters of especial interest were the adoption of a resolution endorsing the Panama-Pacific International Exposition to be held in San Francisco, 1915; the adoption of the drafts of two laws, the first, concerning the licensing of stationary steam engineers, and the second, regulating the construction, inspection and the operation of stationary steam boilers in the State of California.



Delegates at Los Angeles Convention National Association of Stationary Engineers.

After a general discussion of the latter subjects in which every member of the association present was permitted to express his views, both drafts of laws were unanimously adopted, and after due preparation by the secretary, will be submitted to the associations throughout California and other interested parties for perusal, and in due time presented to the next legislature at Sacramento for enactment into laws. These two laws are of the most vital importance to all persons and interests connected with the science of steam

Entrance to Exhibit Hall at N. A. S. E. Convention.

engineering in California, not only as an inducement for engineers to better qualify themselves to fill positions, but as a stimulus to the manufacturing industries of the State, it being a well known fact that the construction of boilers in California has dwindled from various causes to an almost negligible quantity.

The California Metal Trades Association and other leading commercial organizations have pledged themselves to support these measures before the legislature and we are very hopeful for the success of the proposition.

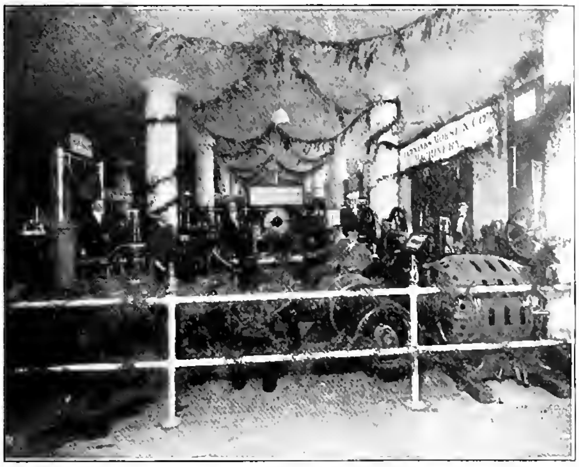
Newly Elected Officers, California State Association, N. A. S. E.

It was unanimously decided to hold the next convention in San Francisco, and the local associations will undertake to arrange a mechanical and electrical exhibit that will not only be a credit to the associations, but to the whole Pacific Coast and to San Francisco in particular, many prominent business firms having already signified their intentions of exhibiting.

The election of officers for the ensuing year resulted as follows: President, Herman Noethig, San Francisco; Vice-President, David Brian, Los Angeles, Cal.; Secretary, W. T. W. Curl, Los Angeles, Cal.; Treasurer, Chas. Knights, San Francisco; Conductor, R. T. Porter, Santa Barbara, Cal.; Door-Keeper, F. W. Coombs, San Jose, Cal.; Trustees, S. F. Riddle, Fresno, Cal.; J. N. Pyster, Santa Barbara, Cal.

Coincident with the sessions of the convention which were held in the Angeles Hotel, the local associations had arranged a splendid mechanical and electrical exhibit located on the fourth floor of the new Hamburger Building, Eighth street and Broadway. As shown by the accompanying photographs, there were many excellent exhibits and the people of Los Angeles were not only greatly instructed but surprised at the extent of the same, and particularly so of those products manufactured in the city of Los Angeles and vicinity.

To the visitors, the most striking feature of the week's work and entertainment was the boosting pull-together spirit everywhere shown by the people of Los Angeles, and every visitor, it is safe to say, went away deeply impressed with the future possibilities of the southern section of this State. In the matter of entertainment, the local committee exceeded every expectation on the part of the delegates and visitors, and left nothing to be desired. All the points of interest, adjacent to Los Angeles, were visited and thoroughly enjoyed, every moment of the time being taken up until twelve o'clock Saturday night, when the banquet given in the cafe in the Hamburger building came to an end. The business and social element of the city were very generously represented around the festive board and many excellent speeches were listened to, Mr. Fred J. Fisher acted as toastmaster, and by the responses obtained to his introductions, demonstrated that the stationary engineers of Los Angeles are wide-awake and hold the respect and esteem of all classes of its citizens.



Booths Nos. 1, 2, 21, 22.

Booth No. 3.

EXHIBITS.

Booths Nos. 1, 2, 21, 22: Fairbanks Morse & Co. occupied a space with one of the largest and most attractive machinery exhibits on the floor, including a 150-h.p. motor, 10-h.p. gas engine, 4-h.p. hoist, 18-h.p. 2-cycle valveless marine steam pump, triplex pump, pipe-cutting machine, and compressor, as well as belting, pulleys and a complete line of steam fittings. C. Dunkelberger was in charge.

Booth No. 3: The Radial Power Hammer Company demonstrated one of their hammers, a recent invention of Mr. F. E. Sutherland.

Booth No. 4: The B. F. Kierulff Jr. & Co. had an attractive exhibit of a high-speed power-pump, transformers, motors, line material and lamps.

Booth No. 5: The Western Gas Engine Company displayed an 18-h.p. gas engine. F. T. Richards was in charge.

Booth No. 6: The booth of the California Industrial Works of Los Angeles was constructed of iron and steel forgings, and contained a display of tested iron used by the company in its manufactures.

Booth No. 7: The Chamber of Mines and Oil showed an instructive collection of ores, oil sands and oils.

Booth No. 8: The Faget Engineering Company, 639 Mill street, Los Angeles, displayed cold storage and refrigerator supplies, especially ammonia tanks of all sizes.

Booth No. 9: The Bowers Rubber Company of San Francisco had an interesting display of packing, hose and belting.

Booth No. 10: The Western Electric Company displayed a 75-h.p., 2-phase, 50-cycle Hawthorn motor and a complete line of electrical and telephone equipment.

Booth No. 11: McKain Manufacturing Company, 921 Main street, Los Angeles, showed pulley, belting and shifting equipment.

Booth No. 12: The Maryland Casualty Company gave an instructive exhibit of defective boiler plates and parts as an object lesson to owners and operators of power plants. Literature was distributed on steam

Booth No. 4.

Booth No. 8.

Booth No. 12.

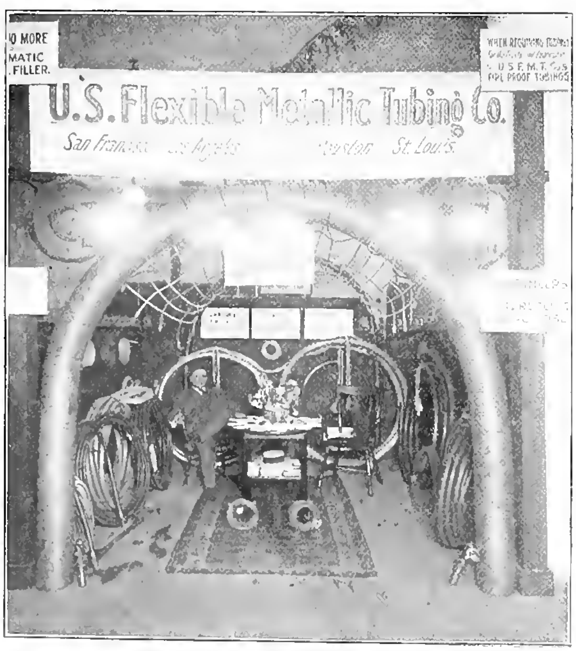
boiler, fly-wheel and sprinkler inspection. Valuable souvenirs were given away. Those in charge were C. M. Hansen, Pacific Coast chief inspector; V. J. North, and Glen Siegler of the Los Angeles office.

Booth No. 13: The Los Angeles Rubber Company displayed a line of engineers' supplies in mechanical rubber goods and packings, also Child's fire extinguishers and Bennett hose racks.

Booth No. 14: Holmes & Kittle displayed one of their Kittle burners.

Booth No. 15: The U. S. Flexible Metallic Tubing Company of San Francisco and Los Angeles were established in a booth the entrance to which was a large arch made of 8-in. suction hose. The roof was covered with gas hose and the display consisted of a general line of copper and steel hose for oil, steam and compressed air. F. J. Stephens, manager of the San Francisco office, was in charge.

Booth No. 16: The Engineers' Supply Company of Los Angeles filled its booth with an attractively arranged display of steam users' specialties. Mr. H. G. Bell was in charge.



Booth No. 15.

Booth No. 17: The Shalck Chemical Company, 405 East Third street, Los Angeles, displayed their Aqua Pura boiler compounds and Hydra Pura water softener.

Booth No. 18: J. B. Coffey Belting Company showed belting and mechanical leather supplies.

Booth No. 19: Western Art Tile Works, 720 South Olive street, Los Angeles, exhibited tile and brick.

Booth No. 20: The front of booth No. 20 was occupied by a furnace extension for a Scotch marine boiler, which proved an interesting attraction. The booth also contained a Cyclone oil-burning system vaporizer for water tube boilers. These are both manufactured by the National Fuel Oil Appliance Company of 632 North Main street, Los Angeles. G. W. Coen, vice-president and manager of the company, was in charge of the booth.

Booth No. 20.

Booths Nos. 23 and 44: The Byron Jackson Company of San Francisco operated a 4-in. centrifugal pump lifting 400 gallons of water per minute. Electric incandescents illuminating the discharge made a brilliant showing at night. E. F. Lewis, manager of the company's Los Angeles office, was in charge.

Booth No. 24: Woodil & Hulse Electric Company's booth was made brilliant by a large electric sign operated by a flasher in the booth. They also showed lines of switchboard panels, fan motors, meters and lamps. W. C. Lloyd was in charge.

Booths Nos. 25 and 26: The Machinery and Electrical Company of 351-3 North Main street, Los Angeles, displayed Snow steam pumps, Sturtevant fans and blowers, Skinner engines, etc.

Booth No. 27: The Los Angeles Pressed Brick Company displayed a line of their fire clay products.

Booth No. 28: Geo. W. Lord & Co. showed samples of their boiler compound, distributing literature setting forth its merits. J. C. Bell, Los Angeles repre-

sentative, and H. L. Gaskill of San Francisco waited on the engineers and visitors.

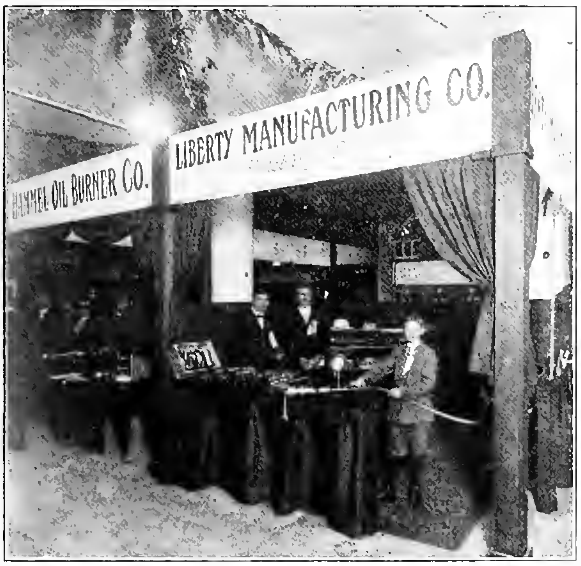
Booth No. 29: A pneumatic water tube boiler cleaner was demonstrated by J. A. Proper, Western representative of the Liberty Manufacturing Company, with offices in the Storey Building, Los Angeles.

Booth No. 30: Kleanit, a washing powder and water softener, manufactured by the Fuller Chemical Company of Los Angeles, and Scalerine boiler compound was displayed.

Booth No. 31: The Home Telephone Company of Los Angeles had set up an automatic switchboard connected up with two phones so that visitors could see them in actual operation.

Booth No. 32: An interesting display of machinery and supplies such as gas and hoisting engines, compressors, pumping plants and air drills was shown by the W. L. Cleveland Company of 218-10 North Los Angeles street.

Booth No. 33: The Standard Oil Company had an artistically arranged display of its various products. C. G. Bailie was in charge.



Booths Nos. 29, 38.

Booth No. 34: F. G. Bobb and R. W. Francis of the Braun Chemical Company, Los Angeles, had charge of the company's display, showing an interesting line of water and oil-testing apparatus and boiler compound.

Booth No. 35: E. H. Taylor, electrician, had an attractive display of electrical supplies and fixtures.

Booth No. 36: On the walls were displayed drawings and photographs of plants in Los Angeles and vicinity furnished by H. N. Strait & Co. of Kansas City, Kansas, manufacturers of Corliss engines. J. F. Connell of Los Angeles entertained visitors.

Booth No. 37: Meese & Gottfried displayed a complete line of their transmission elevating and convening machinery.

Booth No. 38: The Hammel Oil Burner Company showed four types of Hammel oil burners and the Hammel oil-burning furnace. The display was in charge of W. F. Charlton.

Booth No. 30.

Booth No. 39: A one-ton ice machine was exhibited by Will P. Stevens of 1634 Long Beach avenue, Los Angeles.

Booth No. 40: The Pioneer Boiler Works of Los Angeles displayed samples of their manufactures, including boilers, heaters, ore cars and buckets, gasoline engine, gas generator and a line from their pattern shop. A. F. McCowen was in charge.

Booths Nos. 41 and 42: The Pacific Coast Manufacturing Company of Los Angeles showed lines of wood-working machinery and other machinery plants installed by them.

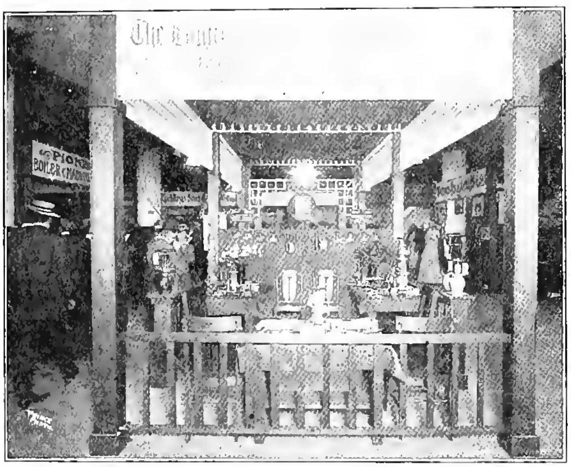
Booth No. 45: A well-arranged and attractively displayed line of fuel and lubricating oils and greases was shown by the Davis Oil Company of 2812 South Main street, Los Angeles. They also displayed their Davis boiler compound. Messrs. Davis and Phippen were in charge.

Booth No. 46: The General Electric Company had an interesting display, showing a 20-kw. Curtiss steam turbine, motors, fans and Mazda lamps. The booth was outlined with 300 sign lamps.

Booth No. 47: The Lunkenheimer Company's display consisted of samples from their line of engi-

Booth No. 34.

Booth No. 45.



Booth No. 47.

neering specialties. Jas. B. Castle of San Francisco and W. F. Balemeyer were in charge.

Booth No. 48: The James Jones Company of Los Angeles displayed a line of their brass goods, including supplies for water, gas, steam, oil wells, etc.

Booth No. 49: The Warren & Bailey Manufacturing Company showed unlubricated flax packing and magnesia pipe covering. The booth contained a well-arranged display of lubricating oils, belting and various engineers' supplies.

Booths Nos. 50 and 51: Henshaw, Bulkley & Co. had an extensive and interesting display of engineering machinery and supplies.

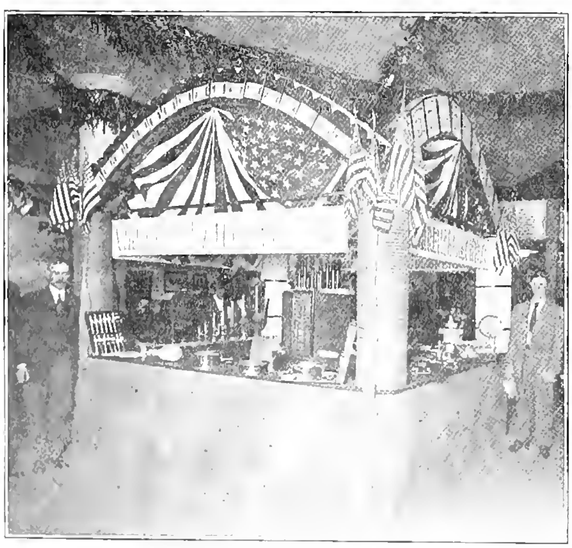
Booth No. 52: The International Correspondence School of Scranton, Pa., was represented by J. T. Brown.

Booth No. 53: Immediately in front of the main entrance to the hall was the booth of the Johns-Manville Company, brilliantly outlined with 35-watt, 27-volt Linolite lamps. The booth was entirely constructed out of the company's products. The four supports of white asbestos pipe covering rested on a base of asbestos roofing coils. The center was occupied by a large pyramid of packing, and arranged about the walls a complete line of pipe covering cork insulation as well as other specialties. One counter was devoted to electric appliances for central stations.

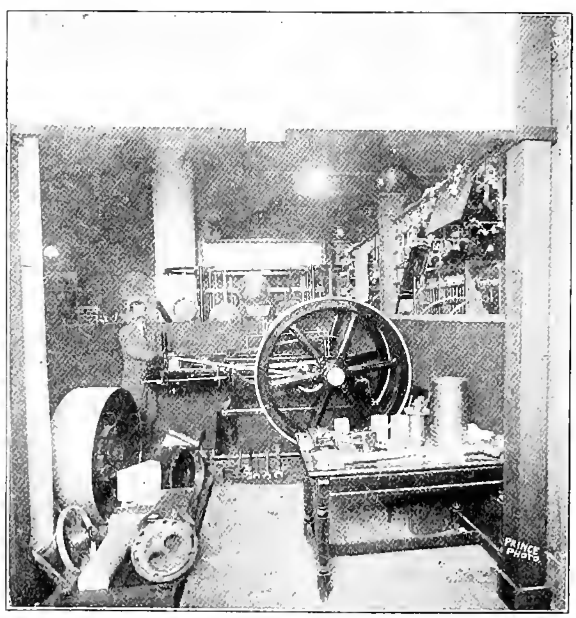
Booth No. 54: The Dearborn Drug and Chemical Company occupied booth No. 54, with an attractively arranged display of the Dearborn preparations for boilers.

Booth No. 55: The Commercial Engine Company of Los Angeles displayed one of the 25-h.p. gas engines with essential parts. J. A. Beck had it in charge.

Booth No. 56: The Hartford Steam Boiler Inspection Company of San Francisco had on display a series of blue print drawings of plans and specifications for steam plants for various purposes. I. G. Hitman and J. B. Warner of San Francisco entertained visitors.



Booth No. 49.



Booth No. 55.

Booth No. 57: A valve exhibit was in charge of C. C. Anderson, manager for Jenkins Bros. in San Francisco.

Booth No. 58: The Pacific Coast Construction Company of Los Angeles displayed pumps, feed water heaters, etc.

Booths Nos. 59, 60, 69, 70: A large space including booths Nos. 59, 60, 69 and 70 in the center of the hall was occupied by the Union Well Supply Company of Los Angeles, with an extensive and well-arranged display of engineers' supplies, including the products of the Boston Woven Hose & Rubber Company, Warren Lubricant Company, Edgar Allen Company, Crefield Waste & Belting Company, Bird-Archer Company, Ludlow Valve Manufacturing Company, Byrnes Belting Company, Germania Refining Company, Garlock Packing Company. H. T. Warner and L. H. Johnson represented the company. One corner of the Union Well Supply Company's space was occupied by the G. E. Witt Company of San Francisco, showing their new feed water regulator and oil burner governors.

Booth No. 61: F. C. Davis of the John Finn Metal Works of San Francisco explained the advantages of the John Finn babbitt metals.

Booth No. 62: Leland & McKee displayed a line of belting and steam specialties. George Leland was in charge.

Booth No. 64: Harron, Rickard & McCone, machinery merchants of San Francisco and Los Angeles, displayed an extensive line of power machinery.

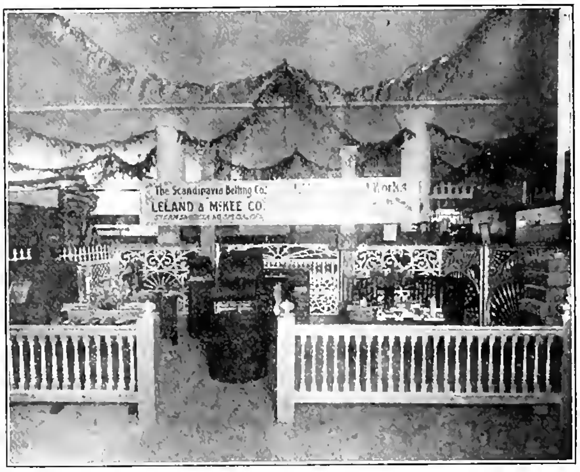
Booth No. 65: F. J. Kimball of 622-23 I. W. Hellman Building, Los Angeles, had in operation a Twentieth Century air lift manufactured by the Harris Pump Company of Indianapolis.

Booth No. 67: The Llewellyn Iron Works of Los Angeles showed the essential parts of their electric elevators.

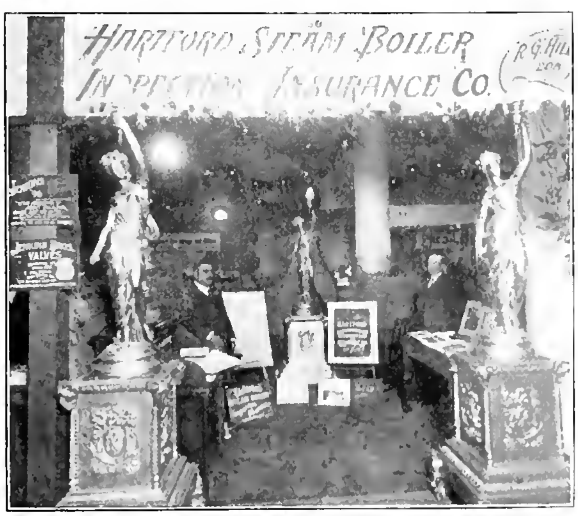
Booth No. 68: The Pacific Clay Manufacturing Company of Los Angeles displayed samples of their fire brick.

Booth No. 71: This display of John Wigmore & Sons Company of Los Angeles consisted of bearing metal, a line of Atkins saws and knives and Cortland corundum wheels.

Booth No. 57.



Booths Nos. 61, 62.



Booth No. 56.

Booth No. 64.

Booths Nos. 72 and 73: Harper, Reynolds & Co.'s display consisted of piston packing.

Booth No. 74: The Cass Smurr-Dameral Company showed furnaces and utensils, also Everson electric vacuum cleaners.

Booth No. 75: The Chamber of Commerce displayed fruits and other products of Los Angeles and vicinity.

Booths Nos. 76 and 77: Headquarters for the committee and the press respectively.

Booth No. 80: T. E. Hoyt & Co. of Los Angeles demonstrated the Morgan auxiliary gas mixer and oiler.

Booth No. 81: Oil well pumps and fittings, as manufactured by the Axelson Machinery Company, were in charge of O. A. Holcomb.

Booth No. 82: The Valvoline Oil Company had a well-arranged display.

Booth No. 83: The P. K. Wood Pump Company and the Keating Oil Burner Company demonstrated their several products.

Booth No. 84: The Pacific States Electric Company with branches at Los Angeles, San Francisco, Oakland and other Coast cities had an interesting display consisting of heating devices, fans, Sprague flexible conduit and complete line of electrical appliances.

Booth No. 86: The Consolidated Sales Company, 1216-18 South Olive street, Los Angeles.

Booth No. 90: Anderson, Lore & Co. displayed steam fitting and plumbing supplies.

Booths Nos. 91 and 92: The Santo vacuum cleaner and Invincible electric cleaner were herein demonstrated.

Booth No. 93: The Sievert Oil Burner Company of Los Angeles displayed a line of domestic oil-burning furnaces.

Booth No. 94: The F. C. Kingston Company showed Duntley portable electric pneumatic cleaners.

Booth No. 95: The Fulton Engine Works of Los Angeles displayed a line of pulleys, rails, frogs, ore cars and buckets.

Booth No. 96: The John Roebling Company's display consisted of wire varying in size from 1/1000 in. up. Their display of aviators' cord attracted attention. P. C. Reed represented the company.

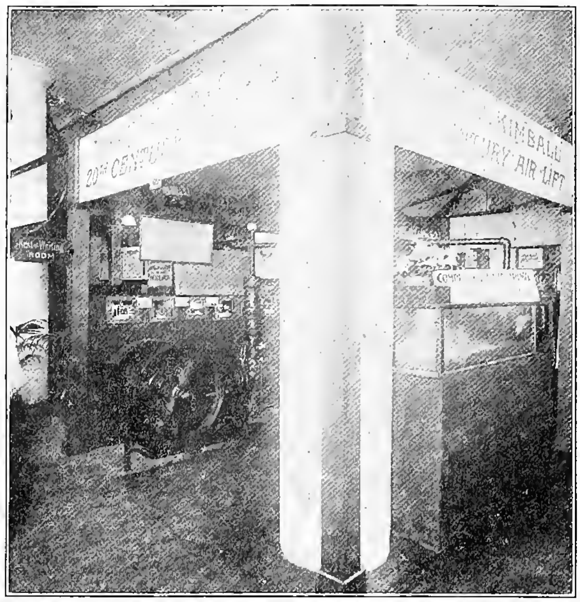
Booth No. 97: The Western Boiler Works displayed products of their factory at 2657 Humboldt street, Los Angeles.

Booth No. 98: The Baker Iron Works of Los Angeles showed steam pumps and compressors, mining drills and laundry machinery.

Booth No. 99: The Lealey Manufacturing Company of Los Angeles exhibited oil burners and their new spark changing device.

Booths Nos. 100 and 101: The Smith-Booth-Usher Company, machinery merchants of Los Angeles, displayed a complete line of steam-fitting supplies, brass goods, steam pumps, machine tools, hand tools and engineers' supplies in general.

Booth No. 102: An attractively arranged display of Noscale boiler compound was shown by the California Engineers' Supply Company of San Francisco and Los Angeles.



Booth No. 65.

Booth No. 82.

Booth No. 99.

KNOTS.

BY W. G. BONNEY.

A great number of knots have been devised of which a few only are illustrated, but those selected are the most frequently used. In the illustration, Fig. 1, they are shown open, or before being drawn taut, in

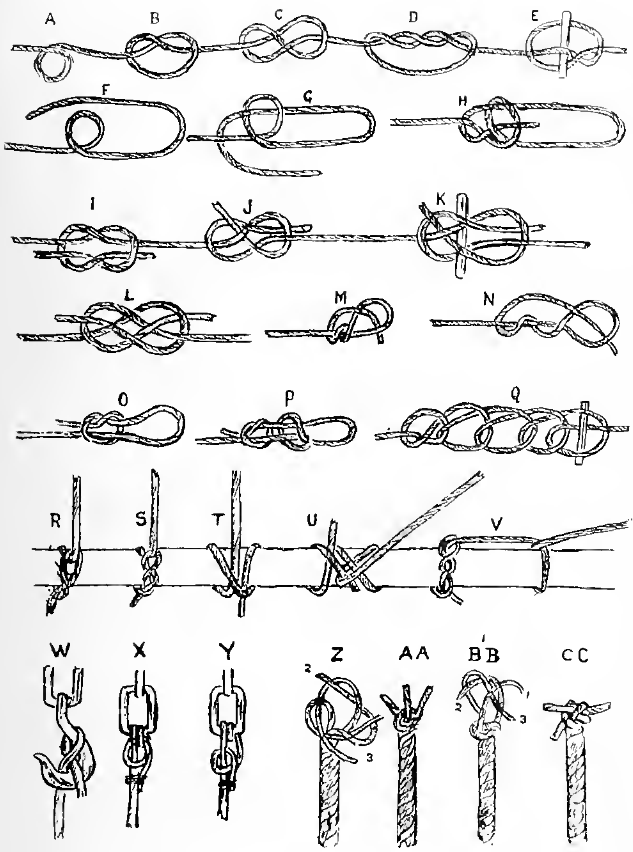


Fig. 1.

order to show the position of the parts. The names usually given to them are:

A. Bight of a rope.
B. Simple or overhand knot.
C. Figure 8 knot.
D. Double knot.
E. Boat knot.
F. Bowline, first step
G. Bowline, second step.
H. Bowline, completed.
I. Square, or reef knot.
J. Sheet bend, or weaver's knot.
K. Sheet bend with toggle
L. Carrick bend.
M. Stevedore knot completed.
N. Stevedore knot commenced.
O. Slip knot.
P. Flemish loop.
Q. Chain knot with toggle.
R. Half-hitch.
S. Timber-hitch.
T. Clove-hitch.
U. Rolling-hitch.
V. Timber-hitch and half-hitch.
W. Blackwall hitch.
X. Fisherman's bend.
Y. Round turn and half-hitch.
Z. Wall knot commenced.
A.A. Wall knot completed.
B.B. Wall knot crown commenced.
C.C. Wall knot crown completed.

The principle of a knot is that no two parts, which would move in the same direction if the rope were to slip, should lay alongside of and touch each other.

The bowline is one of the most useful knots, it will not slip, and after being strained is easily untied. Commence by making a bight in the rope, then put the end through the bight and under the standing part as shown in G, then pass the end again through the bight, and haul tight.

The square or reef knot must not be mistaken for the "granny" knot that slips under a strain. Knots H, K and M are easily untied after being under a strain. The knot M is useful when the rope passes through an eye and is held by the knot, as it will not slip and is easily untied after being strained. The timber hitch, S, looks as though it would give way, but it will not; the greater the strain the tighter it will hold. The wall knot looks complicated, but is easily made by proceeding as follows: Form a bight with strand 1 and pass the strand 2 around the end of it, and the strand 3 around the end of 2 and then through the bight of 1 as shown in the cut Z. Haul the ends taut when the appearance is as shown in A.A. The end of strand 1 is now laid over the center of the knot, strand 2 laid over 1 and 3 over 2, when the end of 3 is passed through the bight of 1 as shown in B.B. Haul all the strands taut as in C.C.

Examination for Engineer in the Indian Service is announced by the United States Civil Service Commission on July 13-14, 1910, to fill a vacancy, at White Earth School, Minnesota, at $800 per annum, and other similar vacancies as they may occur in the Indian Service.

An artificial rubber is said to have been invented by a German professor at Kiel, the invention being based on the boiling of isoprem with acetic acid in a closed tube, there resulting a gray composite stated to have all the properties of pure rubber and capable of being vulcanized.

Lectures on illuminating engineering are to be given during the fall term of 1910 at the John Hopkins University of Baltimore under the joint auspices of the University and the Illuminating Engineering Society. The complete course includes 36 lectures to be given by recognized authorities and to be supplemented by laboratory demonstrations.

Electric smelting of pig iron is proving practicable and economical in Sweden. Experiments show that it requires about 2,000 kw.-hours to produce pig iron from crude ore, another 1,000 kw.-hours being necessary to make pure steel, which, being of better quality, commands better prices and also enables the use of lower grade ores than is possible with other processes. The coke consumption averages .3 ton per ton of pig iron.

THE HISTORY OF GAS-LIGHTING IN SAN FRANCISCO.

BY E. C. JONES.[1]

E. C. Jones.

San Francisco was incorporated in the year 1850. It was even then the largest and most important city in the new State of California, which had only been admitted into the Union September 9th of that year. At that time coal-gas works were being built in many of the older and larger cities of the Eastern States, and gas was being introduced as a lighting agent for the first time. It was in keeping with the progressive spirit and indomitable will of the early San Franciscans that this city should consider the introduction of illuminating gas during the first year of its corporal existence.

Peter Donahue, a pioneer and one of the builders of San Francisco, was then engaged in the foundry business. He and his brother, James, were the first iron founders in California, and their shop at the foot of Telegraph Hill was the nucleus from which grew the present Union Iron Works.

One Sunday in 1850, Peter Donahue, while strolling over the sand hills south of the town, climbed to the top of one on Bush street. Looking down, he was impressed by the rapid growth of the town, and remarked to his friend, Martin Bulger, "Bulger, this is going to be a great city at no distant day. There will have to be a gas works and a water works here, and whoever has faith enough to embark in either of these enterprises will make money from them."

San Francisco at that time had more the appearance of a straggling country town than of a city. Montgomery street was occupied from Washington to Sacramento streets, and there were buildings of a temporary character scattered as far as Pacific street on the north and California street on the south. Washington, Clay and Sacramento streets had buildings as far west as Kearny street, with an occasional dwelling house farther out toward Stockton street. A few dwellings on Stockton street and Dupont street marked the limit of city settlement. Kearny street, north of Sacramento street, with the cross streets, furnished dwellings to most of the inhabitants. The business streets of the town were Sansome and Battery, with Clay, Sacramento and Commercial streets east of Montgomery. Montgomery was the busiest of them all, as it led down to Long Wharf, then the general point of landing and embarkation for all water craft. South of California street were enormous hills of drifting sand. In the neighborhood of Third and Howard streets was Happy Valley, having a small population, while Turk street in the vicinity of Mason and Taylor streets was called St. Ann's Valley; there a small stream of pure water furnished the supply used for domestic purposes in the neighborhood. There was also a settlement at the Mission Dolores, reached by a road winding through the sand hills north and west of Market street.

At that time it was doubted by many whether San Francisco was destined to be the future metropolis of California, owing to the great number of high hills and the absence of any natural supply of water or wood. Even the bracing west winds from the ocean, which now make San Francisco attractive as a summer resort, were urged against it.

Under these circumstances it required courage to propose the investment of money necessary to construct a gas works. Peter Donahue had faith in the ultimate success of his undertaking. He knew little or nothing about the manufacture of gas, but proceeded to study everything on the subject obtainable. The brothers, Peter and James Donahue, then had in their employ a young man named Joseph G. Eastland, who, encouraged by them, took a great interest in gas matters and made a study of the business, with the assurance that the gas works would be built and that his studies would bear fruit.

A franchise was obtained, and the San Francisco Gas Company was incorporated August 31, 1852. The original officers were Beverly C. Sanders, president, and John Crane, secretary. James Donahue was elected president in 1856, and continued in office until his death in 1862.

The beginning of the gas business in San Francisco was fraught with difficulties, owing to the distance from the source of supplies. The Donahue foundry had but one cupola, containing only enough iron to pour a single gas retort, and they were laid aside as completed until enough were made to build the works. There was difficulty in obtaining cast iron pipes for street mains, but these were finally shipped from Philadelphia, round Cape Horn, and were laid in the city streets.

The original works of the San Francisco Gas Company was built on the lot bounded by First, Fremont, Howard, and Natoma streets. The reason for selecting this site was that it was located on tide-water, there being a sharp indentation of the bay at that point. Lighters containing construction material and coal for gas-making were landed directly on the beach at the gas works. That site is now six blocks from tide-water.

The first gas was made from coal brought from Australia and distilled in iron retorts set in benches of three retorts each. It was purified by wet lime purifiers, using lime in solution in water.

The night of February 11, 1854, the streets of San Francisco were for the first time lighted with gas, and in commemoration of the event a banquet was given at the Oriental Hotel. Following is a copy of one of the invitations to this banquet:

SAN FRANCISCO GAS COMPANY.

February 8, 1854.

Sir:—The Trustees of the San Francisco Gas Company request the honor of your company at the Oriental hotel, from 7:30 to 9 o'clock, on Saturday evening, the 11th inst., on the occasion of their introducing Gas Light into the streets of San Francisco.

Very respectfully,
JOHN CRANE, Secretary.

In 1855, the company had twelve miles of street mains, and its storage capacity consisted of two gas holders at First and Howard streets, with a combined capacity of 160,000 cubic feet. The price of gas at that time was $15 a thousand cubic feet.

In 1856 Joseph G. Eastland became secretary of the company, and filled this position through successive years until 1878.

[1]Chief Engineer Pacific Gas and Electric Company's Gas Department.

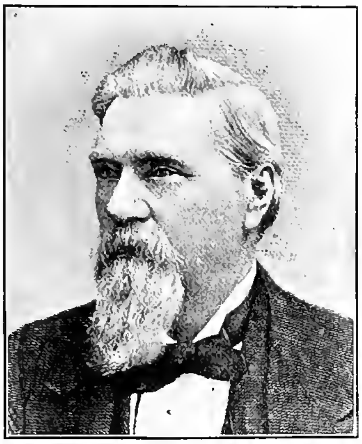
The printed rules of the company in 1855 read as follows:

Gas will be supplied by the meter at the rate of Fifteen Dollars the thousand cubic feet, and where there are no meters, the calculation will be made from the size of the burners.

All Bills are payable weekly. Consumers are respectfully and particularly requested to pay their Bills promptly. In default of payment of Gas consumed, within three days after presentation of the Bill, the flow of Gas may be stopped until the Bill is paid. Service pipe from the main to the Service Cock, will be furnished free of charge, in houses where more than four burners are used. The Company, or its authorized agent, shall at all times have the right of free access into the premises lighted with Gas, for the purpose of examining the whole Gas apparatus or for the removal of the meter and service pipe.

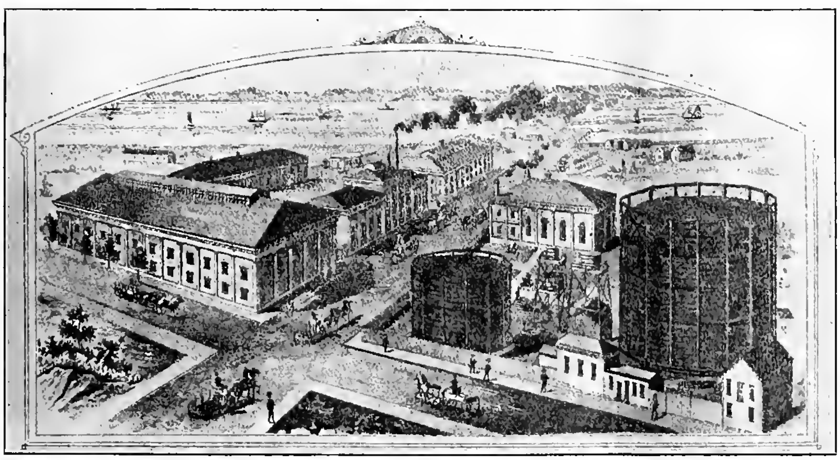
daily. The maximum price for gas was fixed at $4.50. This company had a short life, and was purchased by the old company.

The Metropolitan Gas Company was organized in March, 1871, and began furnishing gas in April, 1872, at a maximum price of $3.50. The plant was located on Mission Block 43, Channel street, southwest of Ninth street. Gas was made from petroleum, distilled in iron retorts, but it was not a success. The company, shortly after its start, was purchased by the San Francisco Gas Company.



Peter Donohue.

The Old Gas Works at First and Howard Streets, Built in 1853.



The North Beach Gas Station Built in 1891.

James Donahue

May 2, 1862, the legislature granted a franchise to the Citizens Gas Company of San Francisco for the full term of fifty years. Two 100 varas at Townsend and Second streets were purchased as a site for the new works, and John P. Kennedy, a gas engineer of New York, was employed to erect the works. Construction was begun in the fall of 1863, but gas was not furnished to the general public until January, 1866. The franchise limited the maximum price that might be charged for gas to $6 a thousand cubic feet. In less than two years, as soon as it was ready to deliver gas, the Citizens Gas Company sold out to the San Francisco Gas Company.

In April, 1870, the City Gas Company was organized. Four blocks of land were purchased at the Potrero, and work was begun June, 1870. When completed the works had a capacity of 1,500,000 cubic feet

April 1, 1873, the San Francisco Gas Light Company was formed, with increased capital and the merging of properties and stock of the San Francisco Gas Company, the Metropolitan Gas Company, and the City Gas Company.

During the year 1882, the Central Gas Company came into the field as an opposition concern, and subsequently took the name of the Central Gas-Light Company. In the competition that followed, the rate for gas went as low as 90 cents a thousand cubic feet. Between 1882 and 1884 the Central Gas-Light Company was leased by the Pacific Gas Improvement Company. This last company existed until it was merged into the San Francisco Gas and Electric Company September 1, 1903.

During all these years coal-gas was manufactured by the San Francisco company, and improvements in

the art were adopted as fast as they made their appearance. Clay retorts were substituted for those of iron, and improved furnace construction increased the yield of gas made from a pound of coal.

In 1888 the production of crude petroleum in California warranted the introduction of the manufacture of water-gas, then in general use in the eastern and middle states. During that year (1888) 690,333 barrels of oil were produced in California. It will be interesting to compare this with the production in 1907, amounting to 40,311,171 barrels.

The gas then made was from anthracite coal brought round Cape Horn from the Port of Swansea in Wales, and enriched with California petroleum.

The first water-gas plant in San Francisco was built at the Potrero gas works. The plant consisted of two Springer generators. At that time the gas was supplied to the city by the old Howard-street works, then making coal-gas, and by the works at the Potrero. The King-street works had been shut down. The manufacture of water-gas proved such a success, owing to the increased amount of petroleum produced and the lessening of the cost, that it was decided to construct a modern gas works, including all of the new improvements in water-gas making, together with a modern coal-gas plant as a protection against a failure or shortage in the supply of oil.

Joseph B. Crockett was then engineer of the company. He had entered the employ of the City Gas Company in 1873, and was engaged at the Potrero during the construction of the works. When that company was merged with the old company he was employed at the Howard-street works under James and William Beggs. William Beggs was the first gas superintendent on the Pacific coast. By reason of his industry and fidelity Joseph Crockett was advanced rapidly to the position of assistant engineer, and then to engineer and on until he filled the position of president-engineer before he was twenty-eight years old. At North Beach, between Bay street, Laguna and Webster streets, and the Bay of San Francisco, and under his direction the North Beach Gas Works was built. It was his pride, and it was recognized for many years as the finest gas works in the world.

It was the good fortune of the writer to become connected with the San Francisco Gas-Light Company in 1891, and to have charge of the construction of this new works under Joseph Crockett. At this works what was then the largest gas holder in the United States west of Chicago was constructed. This holder had a capacity of 2,000,000 cubic feet.

Construction work was begun on this new plant in May, 1891, and the water-gas part of the plant was completed and started making gas in six months. On the completion of this work, the old Howard-street plant was dismantled.

December 11, 1896, the San Francisco Gas-Light Company extended the scope of its business by merging with the Edison Light and Power Company under the new title of the San Francisco Gas and Electric Company. The San Francisco Gas Company continued its corporate existence until December 7, 1903.

The Equitable Gas-Light Company was incorporated February 2, 1898, to make "dollar gas" under a method called the Hall Process, which was never a success, and resulted in the installation of a regular water-gas plant during the year 1900. In August, 1903, this property was sold to the San Francisco Gas and Electric Company.

The Independent Electric Light and Power Company, incorporated March 29, 1899, and the Independent Gas and Power Company, incorporated January 5, 1901, were started by Claus Spreckels. These companies entered into active competition with the old company in both the gas and electric business. The gas works of the independent company was constructed on land adjoining the Western Sugar Refinery at the Potrero and consisted entirely of water-gas apparatus. Four sets of what is known as the double superheated system were first installed. To these have later been added two more water-gas sets. The company constructed a 500,000-cubic-foot relief holder, and a 1,000,000-cubic-foot storage holder.

In November, 1903, these properties were merged into the San Francisco Gas and Electric Company by purchase.

In 1902 the manufacture of crude-oil water-gas, using petroleum solely as a material for gas-making, was being developed in some of the smaller cities of California, and its manufacture and use were so successful and satisfactory that the attention of the larger companies was attracted. In February, 1906, a single oil-gas unit, having a daily capacity of 4,000,000 cubic feet, started operation at the Potrero gas works of the San Francisco Gas and Electric Company. Previous to this, a similar unit had been constructed at the works of the San Mateo Power Company, at Martin Station, in Visitacion Valley, and this works had been connected to the Potrero gas works by a 12-inch, steel, high-pressure pipe, suitable compressors for pumping the gas had been installed, and some of this gas was used in San Francisco. Preparations were under way for increasing the number of oil-gas units at the Potrero station when, April 18, 1906, San Francisco was visited by the greatest earthquake in its history. This earthquake completely destroyed the North Beach station of the San Francisco Gas and Electric Company, and the works of the Pacific Gas Improvement Company. The works of the Equitable Gas Company were also destroyed. At the time of the earthquake the North Beach station was the only plant of these three in operation. A part of the city gas was being made in its water-gas works. The works of the Independent Gas and Power Company and the Potrero station were not injured by the earthquake, and the fires in the generators were not drawn, but had it not been for the oil-gas installation at the Potrero station it would have been impossible to have supplied the city with gas without constructing a new gas works.

When the supply of gas was resumed after the fire Martin Station was then called upon to furnish oil-gas up to its capacity.

The oil-gas unit at the Potrero and the water-gas plant of the Independent Gas and Power Company supplied the rest of the gas needed. After the fire the company added three more 16-foot oil-gas units to the Potrero plant, so that at the present writing the gas supplied to San Francisco comes exclusively from the Potrero station, reinforced by water-gas manufactured at the Independent plant from lampblack, which is recovered as a residual from oil-gas making.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

(Continued.)

CHAPTER VIII.

RATES.

The fixing of a scale of rates for the sale of electrical energy which will be fair to both the consumer and the distributing company is a difficult problem, which will here be briefly outlined. We will confine ourselves to showing why it is that electrical energy cannot be sold to all classes of consumers at the same rate, and further to reproduce schedules of rates as adopted by some of the leading distributing companies throughout the United States.

Electrical energy cannot be stored in large quantities except at a great expense, but must ordinarily be "manufactured" as the demand necessitates. For this reason, it is necessary for the distributing company to provide generating and distributing equipment to handle the maximum demand or "peak load," and since the peak load usually lasts for only a few hours, the system is being operated for the greater part of the day at a production much below its full capacity. The operating expenses, however (except fuel, etc.), remain practically the same, as do the fixed charges, the maintenance, depreciation and interest on the investment. The charges which are proportional to the quantity of energy being generated, such as water, fuel, etc., constitute the smaller portion of the total cost, therefore it is evident that the distributing company can sell electrical energy to consumers using it for a good many hours per day cheaper than it can to consumers using it for only a few hours per day, since the revenue from the "long hours" customer will be greater even at a lower rate, while the manufacturing expense will not be much greater.

To illustrate the above statements take as an example two consumers, each taking the same amount of power, but one of which takes this power for ten hours per day while the other takes it for two hours per day. The equipment necessary to supply each customer is practically the same, as are also the fixed charges. A profit of one cent per kilowatt-hour above operating expenses from the customer taking power for ten hours per day would be more profitable to the distributing company than would a profit of two or three cents per kilowatt-hour from the customer taking power for only two hours. In the first case the gross profit above operating expenses would be ten cents per kilowatt per day, while in the second case it would be four or six cents. Suppose that the fixed charges amounted to 4 cents per kilowatt per day, the two hour customer would yield a profit of only two cents per kilowatt demand per day, while the ten hour customer, at a rate of 2 cents lower, would yield a profit of 6 cents per kilowatt demand per day, or three times as much. In the case of very small consumers, the cost of bookkeeping, meter reading, testing, etc., is disproportionately high; the losses in the distributing system are also out of proportion, which further increases the cost of supplying energy to the small consumer.

The distributing company can afford to sell energy during the "off-peak" period cheaper than it can during the hours of the peak load, since during the period of maximum demand, the equipment is usually taxed to its utmost. An increase in the peak load means an increase in the equipment or else a greater strain and depreciation on the present installation, while an increase in the "off-peak" load can be readily handled with the resulting increase in revenue. Generating and distributing equipment has to be provided of sufficient capacity to take care of the peak load. During off-peak hours, a large part of this equipment is idle. The charges (maintenance, depreciation and interest on the investment) due to this excess equipment provided to handle the peak load are properly chargeable to the cost of manufacture during peak load hours, which makes the cost of producing a kilowatt-hour during this time high.

Since the cost of manufacture is higher during the peak load, it is only fair and just that the consumers demanding current at this time should pay a correspondingly higher rate.

Another point which should be borne in mind when determining the rates made to different customers is the nature of the load with regard to the power factor. The capacity of the generating and distributing equipment is limited by the amount of current to be handled, from which it is evident that the cost of supplying energy to a load o low power factor will be higher than the cost of supplying a similar load (in kilowatts) of a higher power factor. Especially is this true during the period of maximum demand.

(To be continued.)

SPOKANE, WASH.—Official announcement was made by Thaddeus S. Lane, president of the Home Telephone Company of Spokane, on May 30, that by a traffic agreement between the company and the Interstate Telephone Company, also of Spokane, there was brought about the consolidation of more than $2,000,000 of invested capital in eastern Washington, the panhandle of Idaho and points in western Montana. This gives the Interstate company an exclusive connection with the Spokane exchange of the Home company for the interchange of long-distance business between Spokane and all points on the Interstate company's lines in the panhandle of Idaho, eastern Washington and all territory hereafter acquired. It also consolidates the two headquarters and brings them into the Home company's new exchange building. "The Home Telephone Company is expected to have 5000 automatic instruments in operation in Spokane by the first of January, 1911," said Mr. Lane. "The Interstate Telephone Company at present has 2500 instruments installed, covering territory within a radius of 150 miles of Spokane. The company has 1200 miles of long distance circuits, and construction work is being rushed in various parts of the Inland Empire. Mr. Lane also announced that the telephones used by the Interstate Telephone Company will be replaced immediately by automatic instruments of the latest type. The Interstate company's exchange in Post street will be closed as soon as the connections with the new building are made. The instruments will be connected with the Home Company's central through underground conduits and cables. The Home company will have direct connections with all the long distance lines operated by the Interstate company to the following cities: Wallace, Wardner, Kellogg, Mullan, Murray, Harrison, Burke, Coeur d'Alene, St. Maries, St. Joe, Sandpoint, Spirit Lake and Rathdrum, Idaho, and Davenport, Reardan, Ione and Metaline, Wash., as well as points in Montana and along the proposed extension of the Chicago, Milwaukee & Puget Sound line. The lines between Mullan and Missoula, Mont., now are under construction and will be completed next fall.

THE MECHANICS OF THE STEAM ENGINE.

(Continued.)

In the issue of the "Journal of Electricity" for May 28, 1910, a general discussion of the various positions of the parts of the piston crank chain was given.

The parts making up the eccentric and slidevalve chain are simple in their relations of position. Ordinarily the length of the slidevalve rod is great compared with the eccentric radius and the horizontal position of the slidevalve may be taken as the same as the horizontal position of the eccentric center. Knowing the eccentric radius and the angle between the crank and eccentric center—that is, the angle of lead of the eccentric ahead of the crank—the position of the slidevalve for any piston position can be readily determined.

Referring to Fig. 1 in the above mentioned issue, if a circle were drawn about O. with radius equal to the eccentric radius—that is, one-half the eccentric throw—and the angle of lead laid off to intersect this circle then a vertical line through this point of intersection would determine the slidevalve position.

The determination of the velocities of the several parts is more interesting.

The linear velocity of the crank pin is obviously the number of revolutions per minute multiplied by the circumference of the crank orbit, its direction at each instant is at right angles to the crank. Suppose, for example, that an engine is running at 192 r.p.m. and that the throw of the crank is 15 in. Then $15 \times 2 \times 3.14 = 94.2$ inches, the circumference of the crank orbit. $94 \times 192 = 18{,}000$ in. per minute or 300 in. per second, the linear velocity of the crank pin. That is to say if the pin were to fly off it would leave in the direction of the tangent to the crank orbit and would be thrown 300 in. away the first second.

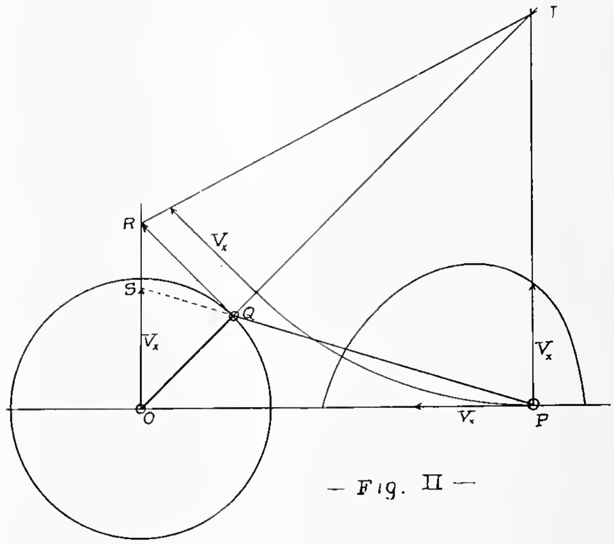
The velocities of other points in the crank are determined similarly by multiplying the revolutions per minute into the circumference of the orbit or circle described by the point in consideration.

The velocity of the piston, or wrist pin, is more difficult to determine. It is, of course, zero at each end of the stroke where the direction of motion reverses, and in general it increases toward the center of the stroke to a maximum and then diminishes to zero at the opposite end. At the point where the crank pin is vertical and its direction for the instant parallel with the crosshead their velocities are the same. If the connecting rod were but very little longer than the crank it is readily seen that the crosshead will be rapidly drawn up toward the shaft as the crank pin travels through its first quadrant, and since it will have passed over more than half of its total distance of travel it will necessarily have passed its point of highest velocity while the crank is passing through the first quadrant. The investigation of this point of maximum velocity is a very complex mathematical problem.

In the papers on Practical Mechanics already printed in this journal the principle of the instantaneous center for determining velocities was explained. The construction in Fig. II utilizes this principle. The point I is the instantaneous center about which the connecting rod is rotating. This is verified since the two ends are each seen to be moving at right angles to the lines drawn to I and hence I must be the center for the instant pictured.

The velocity of Q was in our example found to be 300 in. per second. Lay off a line perpendicular to the crank (or to Q I) 15 in. long and call this the velocity of 300 in. per second; that is, each in. of this line represents 20 in. per second of velocity. Connect the end of this line R with I and then draw the line Vx parallel to Q R at the end of the arc from P. This Vx represents (to the same scale) the velocity of the crosshead at that instant.

If, now, the connecting rod line P Q be extended till it intersects the vertical line through O at S it will be found by measurement (and can be proven true mathematically) that the line O S is equal in length to Vx.



— Fig. II —

Hence by choosing our scale of crank linear velocity numerically equal to the length of the crank the crosshead velocity can be determined for any position by simply extending the line of the connecting rod through to the vertical line from the shaft center.

It will be seen that S will extend above the circumference of the crank pin orbit when the connecting rod is tangent to this orbit and hence the cross head velocity is at this point greater than the velocity of the crank pin Q.

On the backward stroke S will be below the center line indicating the reversed direction of the crosshead velocity.

These velocities may be laid out as perpendiculars from each position and will give the elliptical figure shown. Were the connecting rod very great in comparison with the length of the crank this figure would be an ellipse.

The new Anglo-French telephone cable across the English channel is equipped with Pupin or "loading" coils imbedded in the cores at each knot throughout its length of twenty-one knots. The cable consists of four cores, making two telephonic circuits, and is expected to greatly benefit telephone service between England and France, as the Pupin coil improves the speaking value three times, or gives the same sound volume and clearness of articulation as is obtained with an unloaded cable of one-third the length.

CALIFORNIA OIL FUEL.

BY R. F. CHEVALIER.

(Continued.)

Combustion.

Heat is always liberated when oxygen combines with carbon and hydrogen, which we have already learned to be the chief components of fuel oil. The determination of the amount of this heat and the temperature produced is a branch of thermo chemistry, for all chemical reactions, such as combustion, are accompanied by either the liberation or absorption of heat.

The unit used in these measurements is the amount of heat required to raise a unit weight of water one degree. One pound of water raised one degree Fahrenheit is called the British thermal unit (B.t.u.) and one pound of water raised one degree Centigrade is known as the pound-calorie which is $\frac{5}{9}$ of a B.t.u., this ratio being the same as that between the Centigrade and Fahrenheit theremometer scales. Thus when one pound of carbon is completely burned to carbon dioxide 14,500 B.t.u. are liberated, or enough to raise 14,500 pounds of water one degree Fahrenheit, assuming that all the heat generated is transferred to the water without loss. Only 4,400 heat units are freed when one pound of carbon is burned to carbon monoxide. This shows the effect of imperfect combustion, and it emphasizes the necessity for ample supply of air to completely burn all the carbon present. When the carbon monoxide thus formed is later burned to carbon dioxide 10,100 B.t.u. are freed.

Adopting the chemical nomenclature already explained

$$C + 2O = CO_2$$

means that one equivalent (12 lb.) of carbon is burned with two equivalents (32 lb.) of oxygen to produce 44 lb. of carbon dioxide and evolves 174,000 B.t.u. or $\frac{174000}{12} = 14{,}500$ B.t.u. per pound of carbon. This may be written

$$C, O_2 = 174{,}000;\ \frac{174{,}000}{12} = 14{,}500.$$

$$\text{Similarly } C, O = 52{,}800;\ \frac{52{,}800}{12} = 4{,}400.$$

$$C\,O, O = 174{,}000 - 52{,}800;\ \frac{121{,}200}{12} = 10{,}100.$$

In like manner when one pound of hydrogen is burned with eight pounds of oxygen to form nine pounds of steam, about 62,000 B.t.u. are generated. These values are approximate and differ slightly as determined by different authorities. The following table for which credit is due to Rankine, summarizes these facts:

COMBUSTIBLE.	Lbs. Oxygen per lb. combustible.	Lb. Air (about).	Total British Heat-units.	Evaporative Power from 212° F., lbs.
Hydrogen gas	8	36	62,032	64.2
Carbon imperfectly burned so as to make carbonic oxide..	1 1-3	6	4,400	4.55
Carbon perfectly burned so as make carbonic acid	2 2-3	12	14,500	15.0
Olefiant gas, 1 lb............	3 3-7	15 3-7	21,344	22.1
Various liquid hydrocarbons 1 lb........................	....	....	f'm 21,700 to 19,000	f'm 22½ to 20
Carbonic oxide, as much as is made by the imperfect combustion of 1 lb. of carbon, viz., 2 1-3 lbs.............	1½	6	10,000	10.45

Crude oil as already shown, like all fuels, contains these elements in various proportions and various combinations. Knowing these proportions and combinations, it is possible to calculate theoretically the total heat of combustion. These calculations are useful in that they give a good idea as to how much heat we can obtain from an oil of a given composition. This method is not in general use because few oils have been subjected to a complete chemical analysis, which is an expensive process requiring the services of an expert chemist. We have already shown that crude oil as it issues from the well differs widely in its physical and likewise in its chemical properties. Most California crude petroleum has an asphaltum base as distinguished from the paraffin base of some of the Eastern oils. No oil has a definite chemical composition, but is a mixture of various hydrocarbon series. These include gases, very light liquids, such as gasoline, benzine, kerosene and heavier liquids, such as lubricating oils and finally solids, or asphaltum. The asphaltum base oils contain a large proportion of the hydrocarbons, such as bitumen, pitch and tar and contain relatively more carbon than do those of paraffine base. When chemical analysis of an oil is available it is first necessary to determine the proportion of carbon, hydrogen and oxygen present. When hydrogen and oxygen exist in the proper proportions to form water they have no effect on the total heat of combustion and, therefore the excess of hydrogen is all that is to be used in computing the total heat of combustion. The following formula of Dulong's is frequently used, C, H, & O being the fractions of one pound of a compound and h being the total heat of combustion of one pound of the compound in B.t.u. then

$$h = 14{,}500 \left\{ C + 4.28 \left(H - \frac{O}{8} \right) \right\}.$$

A more practical method, and that usually adopted is to determine the heat value of an oil by some one of the calorimeter methods.

To obtain the maximum furnace temperature we, therefore, require sufficient air to supply the oxygen necessary for complete combustion. Seventy per cent of the entering air contains nitrogen which is useless as a supporter of combustion, and not only tends to reduce the furnace temperature, but carries away a quantity of heat in the flue.

It is fully as important to minimize the amount of air as to be assured of a sufficient quantity entering the furnace. For the effect of excess air upon combustion is to reduce the temperature produced and increase the relative weights of the products of combustion. As the temperature is reduced there is a loss in efficiency, since the lower the initial temperature the less rapidly will be the heat transference, the result being that the final temperature will be greater, and with a correspondingly greater volume and weight of the gas the greater the heat loss by this source. It, therefore, develops that for a theoretically efficient furnace, eliminating loses by radiation and waste gas, no free oxygen should be present in the gases after complete combustion. The efficiency of a furnace may, consequently, be determined by flue gas analysis which is the next division of our subject.

(To be continued.)

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NOTICE TO ADVERTISERS

Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
Entry changed to "The Journal of Electricity, Power and Gas," August 15, 1899.
Entry changed May 1, 1906, to "The Journal of Electricity, Power and Gas," Weekly.

FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

House Organs

A recent meeting of the Technical Publicity Association was devoted to a discussion of the house organ as a medium for profitable publicity. The argument, like the subject, was somewhat one-sided, being debated mainly by its successful proponents. Of the speakers there was no one among the many who have passed this chrysalis stage in the development of a successfully advertised business, and but a single representative of the legitimate technical press.

In the broad field of specialized journalism we distinguish three divisions; first there is the high-class technical periodical, including the transactions of the various scientific and engineering societies; next, there is the trade paper for the man interested in buying and selling; and lastly there is the house organ, which may be said to super-specialize on the products of one manufacturer. Those in the first classification are characterized by a high subscription price, and are usually published to promote scientific development, advertising being an incidental though frequently necessary accompaniment. Those in the second class have a nominal subscription charge and are avowedly published for the profit from the advertising. Those of the last sort are circulated freely and contain the advertising of the firm who is paying for the publication. The reader pays for the first two kinds because he wants them; he reads and preserves them because he has paid for them. The publication that is foisted upon him usually receives but scant attention and soon finds its way to the waste basket.

Some house organs are beautifully printed and handsomely illustrated, many of them contain valuable data. They suggest a magnificent house, superbly built on a sightly point of rocks jutting far out to sea. The architect has surpassed himself in its design and the artist has spared no pains in its decoration. The bleak promontory is so buffeted by wind and wave that no tree nor shrub is there to soften its outline. It is the most prominent feature in sight, admired by all who pass by land or sea. Yet, its owner is the personification of loneliness, and an object of pity even among those who admire. How much more attractive would that same house appear if placed in a city among those of its kind, surrounded by great trees, partially covered with trailing roses and flanked by spreading lawns! In the city it is the center of social life; on the coast it is the headquarters for a shooting expedition or a fishing party. An occasional visit is pleasurable, but continued residence becomes isolation.

Similarly the house organ performs an important function in supplementing the statements made in the advertising columns of a magazine. It is a valuable auxiliary, but has not the impartiality that begets confidence. Comparison, without which decision is difficult, is also lacking in house organs. It is correspondingly easy in the columns of the technical press when an advertisement appears in good company and where it is sought by the man who wants to buy, but has not the time to search through fifty or sixty house organs.

PERSONALS.

L. R. Jorgensen, designing engineer with F. G. Baum & Co., is at Bakersfield.

William Bealleau, an electrical engineer of Los Angeles was at San Francisco last week.

W. G. Kerckhoff, of the Pacific Light & Power Company, of Los Angeles, is in San Francisco.

H. R. Noack, of Pierson, Roeding & Co., San Francisco, has gone to the Yosemite Valley on a vacation.

C. E. Groesbeck, vice-president and Pacific Coast manager of H. M. Byllesby & Co., is in Los Angeles.

W. E. Miller, first vice-president of Fairbanks, Morse & Co., gas engine manufacturers, is at San Francisco.

A. L. Havens, manager of Pierson, Roeding & Co.'s Los Angeles office, is a visitor at the San Francisco office.

R. S. Chapman, engineer for H. M. Byllesby & Co., with headquarters at San Francisco, made a trip to Portland last week.

W. B. Cline, president of the Los Angeles Gas & Electric Company, recently returned to Los Angeles from the Orient.

F. B. Gleason, manager of the Western Electric Company's San Francisco house, has returned from a trip to Salt Lake City.

T. B. Hunter, president of the Monterey County Electric Light & Railway Company, spent part of last week at San Francisco.

Hugh Thomas of Salt Lake City, who is superintendent of the Nevada Telephone Company, has been spending a few days at San Francisco.

C. E. Lytle has been appointed manager of the Hillsboro, Washington, Water, Light & Power Company, to succeed A. J. Stephenson, resigned.

H. Mellman, who was connected with the California Electric Construction Company's San Jose branch during the past year, has returned to the San Francisco house.

H. G. Behneman, of San Francisco, has been appointed representative of the John R. Cole Company, in charge of the company's Seattle office. He arrived there June 1.

W. W. Freeman, vice-president and general manager of the Edison Electric Illuminating Company of Brooklyn, N. Y., has been elected president of the National Electric Light Association.

C. C. Caven, salesman with the Western Electric Company's San Francisco house, while swimming fell and met with injuries that disabled an arm and confined him in a hospital for a number of days.

A. G. Wishon, manager of the San Joaquin Light & Power Company, of Fresno, which is extending its system from Lemoore into the Coalinga oil field, was a San Francisco visitor during the past week.

H. H. Sinclair, general manager of the Great Western Power Company, recently returned from an eastern trip. Mr. Sinclair is visiting the electric power plant and dam at Big Bend this week, accompanied by George R. Field, assistant general manager.

J. Hyderdahl Hansen, turbine designer with the Pelton Water Wheel Company, sailed for Europe lact week and will revisit old scenes at Jessum, Norway. He will then make an extended tour throughout Norway, Sweden, Denmark and Switzerland, making inspections and collecting data on European turbine practice.

Axel Hultman and H. Olsson, engineers of the telephone system for the city of Stockholm, have completed an inspection of the automatic telephone system installed by the Home Telephone Company of San Francisco. They will return at once to Sweden and report on their observations concerning the telephone practice in the American cities visited.

SECOND CENSUS REPORT ON CENTRAL ELECTRIC LIGHT AND POWER STATIONS IN 1907.

The second Census Bureau report, prepared in conformity with the act of Congress of June 7, 1906, providing that statistics concerning central electric light and power stations shall be collected by that Bureau at quintennial periods, is now in press.

In Director Durand's letter of transmittal to Secretary Nagel of the Department of Commerce and Labor, it is stated that the statistics were collected under the supervision of Wm. M. Steuart, chief statistician for manufactures in the Census Bureau. T. Commerford Martin of New York City is credited with the authorship of the section dealing with the technical features of the industry. The analytical tables and textual verifications were made by Frank L. Sanford.

The report presents statistics concerning the physical equipment, service, and financial operations of the stations mentioned. This census relates to the calendar year 1907 and it is the second census of the central electric stations that has been taken since the Census Bureau was made a permanent office. The first covered the calendar year ending December 31, 1902. In order to preserve the comparability of the data the same form of schedule was used to collect the statistics of both censuses and the same form of presenting the data has been followed in both reports.

The report is in eight chapters and to these are added general tables, appendices, maps, diagrams and illustrations. The first chapter is a general discussion. The second gives a summary of the statistics. The third relates to power equipment. The fourth covers line equipment. The fifth is devoted to capitalization. The sixth gives the cost of construction and equipment. The seventh deals with income and expenses. The eighth embraces the technical aspects of the period.

There are 148 tables, of which 32 are general in character. The first of all these general tables is a comparative summary of commercial and municipal central electric stations, by states and territories, for 1907 and 1902. The other eight tables on this subject show, by states and territories, for 1907, primary power and generating equipment; substation equipment, motors, transformers, meters, customers, and output of stations; analysis of service; analysis of income; analysis of supplies, materials, and fuel; number of salaried employes and total salaries; average number of wage-earners and total wages; and analysis of miscellaneous expenses. Nearly similar data are contained in the next twenty tables relative to commercial central stations and municipal central electric stations.

The last three of the 32 general tables give an analysis of arc-lighting service furnished by plants operated in connection with electric railways, for 1907 and 1902; an analysis of incandescent and other varieties of lighting service as well as motor service and number of meters, by states, 1907 and 1902; and income, by states, 1907 and 1902.

The maps are three in number and the first shows the geographic divisions; and the second and third, central electric stations, gross income, 1907 and 1902.

There are seven diagrams, the first relating to central stations and electric railways, by character of primary power, 1907 and 1902. The second refers to central stations, by character of primary power, 1907 and 1902. The other five relate to central electric stations and separately refer to; primary power, by states, arranged in the order of their relative importance, 1907 and 1902; steam and water power, by states, arranged in the order of their relative importance, 1907; capacity of dynamos, 1907 and 1902; capacity of dynamos by states, arranged in the order of their relative importance, 1907 and 1902; and output, by geographic divisions, 1907 and 1902.

There are twenty-five artistically executed illustrations, mostly half tone, scattered throughout the report.

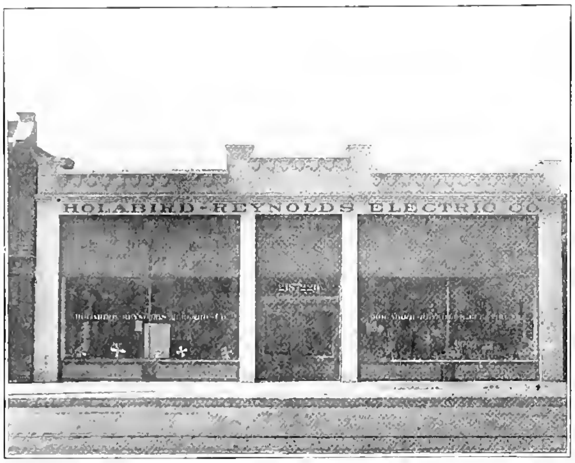
INDUSTRIAL

THE HOLABIRD-REYNOLDS COMPANIES.

In August of 1904 the Holabird-Reynolds Electric Company was incorporated by R. D. Holabird and Robert L. Reynolds, the purpose of the corporation being the wholesaling of electrical supplies. At that time the business was located at 116 East Fifth St., Los Angeles, in a room 18 by 66 ft., with a basement somewhat larger in dimensions.

Since that time this business has grown, until now the company is operating wholesale stores at 523-525 Mission Street, San Francisco, 307 First Ave. So., Seattle,. and 218-220 E Third st., Los Angeles.

The illustrations on this page show the parent house in a new one-story and basement brick building 50 by 125 ft.



Exterior of Los Angeles Store.

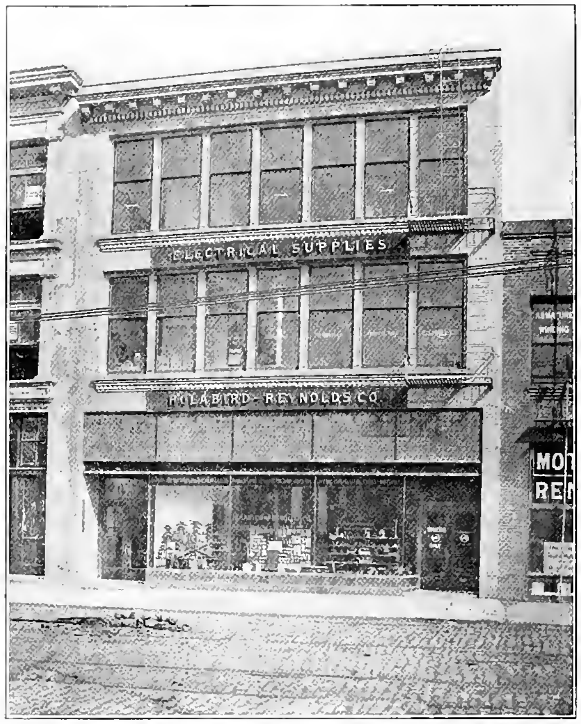
The San Francisco store occupies the entire new three story and basement building at 523-525 Mission Street in the heart of the wholesale district. The Seattle store was opened just one year ago and last October it succeeded to the electrical supply business of the Kilbourne & Clark Company.

The three stores occupy a combined floor space of about 40,000 sq. ft., all of which is devoted to the storage and handling of electrical supplies at wholesale. The sales force consists of twenty-one experienced men. The Los Angeles store is under the management of Newton W. Graham, who has been connected with the company since its organization. The San Francisco store is managed by Harry A. Sayles, who has occupied his present position nearly five years and who has had about eighteen years experience in the electrical supply line in San Francisco. The Seattle store is under the management of Everett J. Dwyer, who has been with the San Francisco store continuously since the commencement of its business. The Portland office, recently opened, is at 614 Couch Building, C. G. Stewart, representative.

For prompt shipment, prompt billing, proper price, and in fact all that goes to make up proper service to its customers, The Holabird-Reynolds Companies feel especially proud. In addition to its business of wholesaling electrical supplies The Holabird-Reynolds Companies are exclusive Pacific Coast representatives of the following important and well known manufacturers:

Franklin Electric Mfg. Co. of Hartford, Conn., manufacturers of Mazda, tantalum, Gem and carbon filament incandescent lamps.

The Ohio Brass Co. of Mansfield, Ohio, manufacturers of Hi-Tension porcelain insulators, and special porcelain pieces for high-tension work.



Exterior of San Francisco Store.

The Sterling Varnish Co. of Pittsburg, Pa., manufacturers of the well known line of Sterling insulating varnishes.

The Pittsburg Insulating Co. of Pittsburg, Pa., manufacturers of insulating cloths.

Interior of San Francisco Store.

The Electric Porcelain Co., of East Liverpool, Ohio, manufacturers of porcelain tubes and insulators for low tension work.

The Pacific Electric Heating Co. of Ontario, Cal., manufacturers of the Hot Point electric iron.

Exterior of Seattle Store.

Interior of Seattle Store.

Holabird-Reynolds Company also handle the product of the following manufacturers:

Arrow Electric Company.
American Circular Loom Co.
Bryant Electric Company.
Crouse-Hinds Company.
General Electric Co.
Hart & Hegeman Mfg. Co.
National Carbon Co.
National Metal Molding Co.
Paiste H. T. Co.
Pass & Seymour.
Proctor-Raymond Co.
Perkins Elect. Switch Mfg. Co.
Weber Electric Company.

STEAM AND AIR FLOW METERS.

The recording and indicating steam meters, manufactured by the General Electric Company, Schenectady, N. Y., have been designed to show the amount of air, steam, or other fluids being delivered for any particular purpose.

The type R, form D, recording flow meter, shown in Fig 1, records the rate of flow of steam in pounds per hour, in pipes of any diameter, and any condition of temperature, pressure or moisture met with in commercial practice. The instrument is designed to give an accurate record on periodically intermittent flow, such as occurs in operating reciprocating steam engines, pumps, etc., as well as on constant flow of steam,

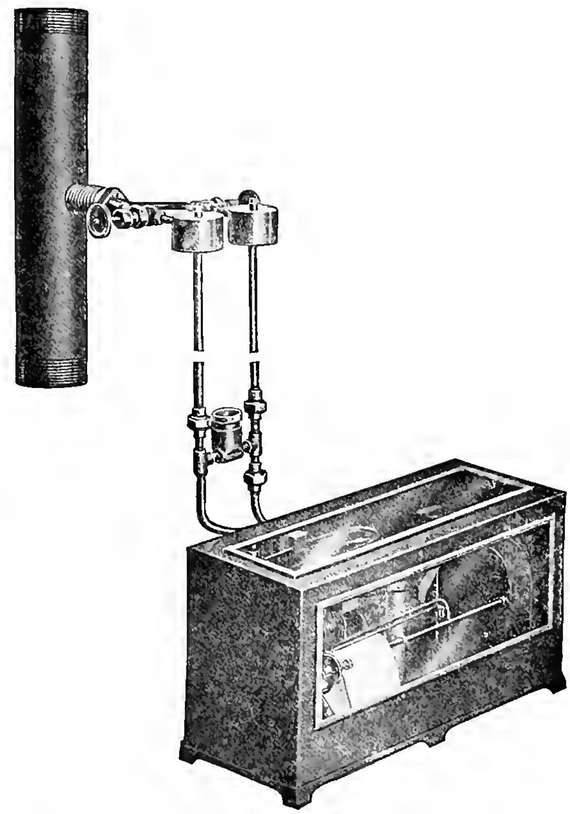


Fig. 1. Recording Steam Flow Meter With Automatic Pressure Correction.

provided it is recalibrated after being installed, or the arrangement of the piping permits inserting the nozzle plug, shown in Fig. 2, at a point in the steam main where the flow of steam is constant.

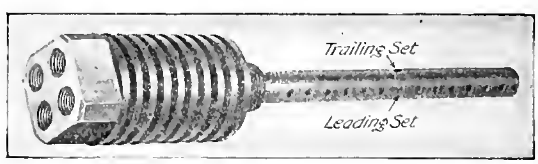


Fig. 2. Nozzle Plug for Flow Meter.

The services for which the meter is adapted are that of recording the total amount of steam generated by a boiler or battery of boilers, recording the amount of steam delivered to any department of a manufacturing plant and recording the amount of steam sold for power, heating or manufacturing purposes.

It also enables the equalization of load on individual boilers of a battery, and is a means of discovering losses due to leaks between the boiler and the point of consumption. It may also be used to determine the deterioration of efficiency of a boiler due to the formation of scale, besides being a

meaus of determining the efficiency in the method of stoking.

The meter consists of two cylindrical hollow cups filled to about half their hight with mercury. The cups are joined together at the bottom, forming a U-tube which is supported on and free to move as a balance about a set of knife edges.

A difference in pressure in the nozzle plug is communicated to the cups by flexible steel tubing placed within the case. This difference of pressure causes the mercury to rise in the right-hand cup and fall in the left-hand cup until the unbalanced column of mercury exactly balances the difference in pressure.

By this displacement of the mercury, the beam carrying the cup moves downward on the left-hand side of the knife edges until the movement of the weights on the right of the knife edge exactly balances the moment caused by the displacement of the mercury in the right-hand cup. The movement of the beam is multiplied by levers and actuates a pin which moves in proportion to the amount of mercury displaced.

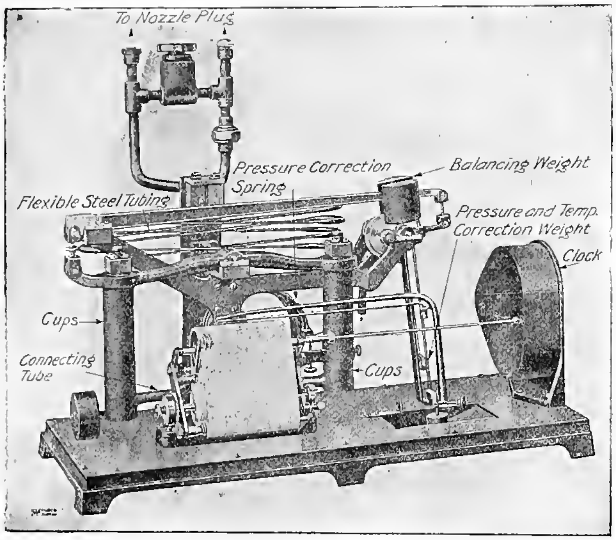


Fig. 3. Recording Steam Flow Meter With Automatic Pressure Correction.

The recording drum feeding the paper is driven by an eight-day clock. The paper on which the record is made is so calibrated that the rate of flow in pounds per hour may be read at any instant, or the average rate calculated for a given time.

For compensating for variation in pressure and temperature a hollow spring is provided, similar to the pressure spring in a steam gauge, and is connected so as to be influenced by the steam pressure at the point where the flow is being measured. Any variation of the static pressure causes the spring to extend or contract, and this movement actuates a small correction weight in such a manner as to affect the deflection of the pin so that the indicated rate of flow recorded is correct for the pressure existing in the steam main. Fig 3 shows this recording meter with the automatic pressure-correction device attached thereto.

Compensating for temperature variation is made by an independent hand adjustment of this same correction weight which corrects the reading for pressure fluctuation. This adjustment is made by increasing or decreasing the distance of the correction weight from its point of suspension, and this distance is determined from a chart sent out with each meter. When the temperature and pressure of steam are practically constant, the recording-flow meter is not fitted to the automatic pressure-compensating device.

Another design of meter is known as an indicating-flow meter, type I, form F. This meter has been designed for indicating rather than recording the flow of steam, gas or air, and is found especially useful for testing work, locating troubles due to leaks, etc. It will register at any condition of temperature, pressure or moisture met with in commercial practice. When measuring a steam flow, it is said to give a true indication of the instantaneous rate of flow in pounds per square inch of pipe cross-sectional area.

Use is made of the nozzle plug for obtaining a difference in working pressure proportional to the velocity, in the same manner as in the recording meter. If the temperature and pressure of the gas be constant, the rate of flow in the pipe will be proportional to the velocity. To measure the velocity, a nozzle plug, Fig 2, is screwed into the pipe at the point where the flow is to be measured. One set of openings, known as the leading set, extends horizontally across the steam main and faces against the direction of flow. The other three openings near the center of the plug constitute the trailing set. The steam impinging against the leading set of openings sets up a pressure in them which is equal to the static pressure plus the pressure due to the velocity head. The pressure in the trailing set is equal to the static pressure minus a pressure due to the velocity head. This difference of pressure existing in the two sets of openings is communicated through separate longitudinal chambers to the outer end of the plug, and from there by proper piping to the meter.

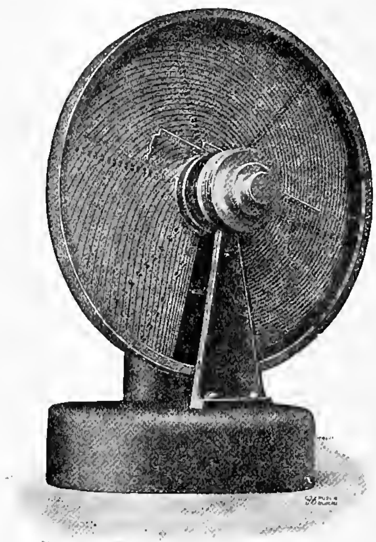


Fig. 4. Disk of Indicating Steam or Air Flow Meter.

The meter itself consists of an iron casting which is cored out to form a U-tube. This is filled for a part of its hight with mercury or water, depending on whether the meter is to be used for measuring steam or water. A difference in pressure in the nozzle of the plug causes a difference of level of the liquid in the U-tube. A small float, suspended by a silk cord, actuates a pulley over which the cord passes. The pulley in turn moves a small bar magnet on the end of the shaft next to the dial in proportion to the change in level of the working fluid in the U-tube.

The dial can be rotated until the indicating needle reads zero when the valve in the by-pass is open. Opening the valves also prevents the blowing out of the working fluid in the U-tube by excessive pressure in either leg. Adjustments of pipe diamter, temperature and pressure are readily made by setting the graduated cylinder, which actuates the rack carrying the pointer. When these settings are made, the rack is rotated by hand until the pencil coincides with the indicating needle. The point on the graduated scale at the intersection of the needle and pointer, Fig. 4, gives the true instantaneous rate of flow in square inches of pipe area.

NEWS NOTES

FINANCIAL.

SULTAN, WASH.—The Town Council has ordered advertising for bids for a water system, in accordance with an election held Saturday, at which bonds to the amount of $14,-500 were voted for the construction.

ASHLAND, ORE.—A special election will be held on July 2d to authorize two bond issues aggregating $55,000. One issue of $30,000 is to pay for paving the street, intersections and crossings under improvements now projected, and $25,000 is desired to complete the municipal electric light and power plant.

EUGENE, ORE.—Sealed proposals will be received by the Common Council of the City of Eugene until 7:30 o'clock p. m. June 27th, for the purchase of the whole or any part of an issue of $60,000 water improvement bonds, to be issued in the denomination of $100 to $1000, bearing interest at the rate of 5 per cent.

SALEM, ORE.—Engineer J. T. Whistler, in a report to Mayor Rodgers and the City Council, estimates the cost of the mountain water system with a distributing capacity of 10,000,000 gallons a day, at $1,450,000. This contemplates the Little North Fork of the Sanot dam as a source of supply. The cost for the maintenance is given at $115,900 per annum. The cost of building a line to the Breitenbush river is estimated as $1,780,000 and with a capacity of 15,000,000 gallons a day. The estimated annual cost of operating the Breitenbush systems is $155,000 and the Willamette river filtered system $109,650.

INCORPORATIONS.

ELLENSBURG, ORE.—Articles of incorporation for a $1,000,000 power company have been filed. The incorporators are: J. C. Donnelly, owner of the Donnelly Hotel in Tacoma; H. J. Maby, commercial agent of the Milwaukee Railroad, with offices in Tacoma.

SAN FRANCISCO, CAL.—Incorporation papers have been filed by the Richmond Light & Power Company, with a capital stock of $2,500,000. Sidney F. T. Brock of Philadelphia, J. S. Lamson of Oakland, Allen L. Chickering and Winfield Dorn of Oakland and Evan Williams of San Francisco are the directors. Chickering & Gregory are the attorneys for the corporation. Allen L. Chickering says that the new corporation was in effect a re-incorporation of the Richmond Light & Power Company, a $300,000 organization. Brock, an attorney of Philadelphia, represents a large block of Eastern capital which will be put into the new concern. The main offices will be in San Francisco. It is said the object of the new company is to take over the present Richmond Light & Power Co. and make improvements to the plant to meet the growing demands of the surrounding country.

TRANSMISSION.

CITY OF MEXICO, MEX.—The Cole-Ryan people of which R. Linton is superintendent, will install a 300 horsepower steam power plant to generate and transmit electrical power a distance of ten miles to a mine.

TACOMA, WASH.—Commissioner Lewson has been directed to advertise for bids for the construction of the substation building for the Nisqually power plant, to be located at South Twenty-fifth and C streets at a cost of $96,200.

EUGENE, ORE.—Bids have been received by the Eugene Heating and Electric Power Company for the erection of a brick or cement power house on the northeast corner of the block bounded by Willamette, Ninth, Olive and E. Eighth streets.

REDDING, CAL.—The Northern California Power Company announces that work will be begun at once on the construction of the Coleman plant. In seven months the entire plant will be in operation. The Allis-Chalmers Company has the contract for the supply of the hydraulic turbine machinery, including all the electrical machinery. The order consists of three hydro-electric units of 7000 h.p. each, which include three 7000 h.p. single horizontal turbines, three 5000 kw. generators and two 250 h.p. single phase exciter turbines. These generators, a new feature here, will operate under a 480-foot head, from two pipe lines 3400 feet long by six feet in diameter. The voltage will be stepped from 6600 to 66,000. The four plants in the different Battle Creek sections are all interconnected with the present line to Chico, and the company is building another line from Coleman, on the south side of the Sacramento river to Hamilton City, and will there connect with a branch line from Hamilton with Chico, at Nord. To prepare for the amount of water that will be required for the largest single installation in the company's system, a main ditch will be dug 16 feet on the bottom, 20 feet on the top, and seven feet deep. Steam shovels used with great effect in previous recent work of the company in the Manton country will be the main digging apparatus, one shovel having made a record of 450 feet of a ditch a day, that would carry 11,000 inches of water. The second steam shovel has been ordered to augment the digging force.

ILLUMINATION.

MERIDIAN, CAL.—Surveys and other preliminary steps are now being made at Meridian for the erection of the substation for the Pacific Gas & Electric Company.

SAN LEANDRO, CAL.—At a special meeting of the San Leandro Board of Trustees a franchise was granted to the People's Electric Light & Power Company to operate in this city.

ALAMEDA, CAL.—The city will have to go to the expense of about $15,000 it is estimated to install a receiving plant if the municipality purchased current during the daylight hours for its electric light and power department as recommended by the Electricity Commission.

CHICO, CAL.—The Diamond Match Company has entered into a contract with the Pacific Gas & Electric Company for electric power to operate all departments of its manufacturing plant at Barber, a suburb of Chico. The contract calls for 1200 h.p., but only about 750 h.p. will be used at the outset.

ESCONDIDO, CAL.—With its electric lighting and power plant in successful operation, the Escondido Utilities Company is now installing a gas plant with a capacity sufficient for a city with a population of 10,000. The undertaking will be completed by July 1st.

LOS ANGELES, CAL.—At a special meeting of the officials of this corporation last week it was decided to drop all improvements and extensions within the city and to return to the treasury of the corporation the greater part of the $3,000,-000 fund put aside for the yearly work of advance in the city and county. This action was taken as the result of the adoption of an ordinance by the City Council lowering the lighting rates from 9c to 7c per kw. an hour.

PHOENIX, ARIZ.—L. H. Chalmers, president of the Pacific Gas & Electric Company, has just returned from Washington, where he went to oppose any action by Congress for validation of a proposed bond issue of $300,000 for installation of a local municipal electric light and power system. His

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principal arguments were that the company's rates are reasonable, though they would willingly be submitted to arbitration and that the city already is heavily bonded for public utilities.

BAKERSFIELD, CAL.—The Kern River Oilfields of California, Limited, which on April 1st took over the Imperial and thirty-three properties in the Kern river field and large acreage of undeveloped land from Keith & Mack, has plans for the installation of an electric plant and for drilling a sufficient number of wells on sections 19 and 25 of the Keith & Mack properties to increase the production 350,000 barrels yearly, this work to be done forthwith. The electric plant is to cost $250,000.

SAN JOSE, CAL.—The National Park Electric Power Company was incorporated here in 1903, with the following San Jose people as directors: A. C. Kuhn, president; C. J. Kuhn, secretary and manager; R. W. Hersey, P. J. Dunne, C. W. Quilty. The chief engineer is G. S. Wakefield. While denying that the company intends in any way to interfere with San Francisco's Hetch-Hetchy water supply, Wakefield admits that there might be a conflict on the question of electricity. This company has again applied for water rights on the Tuolumne river.

TRANSPORTATION.

BURBANK, CAL.—A committee is negotiating with Ed. Goode, president of Glendale Railway Company, to extend the road here. Mr. Goode will build a track for a bonus of $40,000. The road will be single track.

DOUGLAS, ARIZ.—Phelps, Dodge & Co. of Douglas have agreed to finance the building of a new railroad from Silver Bell in Pima county to Port Lobos on the Gulf of California, a project of F. M. Murphy of Prescott.

SAN FRANCISCO, CAL.—By a unanimous vote the Supervisors have adopted the resolution which denied the permit to the Sutter Street Railway Company to operate its cars over the outer tracks in Market street to the ferry.

SAN BERNARDINO, CAL.—$326,000 is to be used in developing resources of Yucaipa Valley. It is expected that work will soon be commenced on the construction of an electric railway which is to link the valley with Redlands and San Bernardino. The line will be built by the Redlands-Yucaipa Land Company.

LOS ANGELES, CAL.—With the closing of the transaction whereby H. E. Huntington became owner of 675 acres at San Dimas, known as Paddingstone Falls, Pomona is assured of a main line connection with Los Angeles via Covina on the Pacific Electric road. The electric line will run through Puddingstone canyon, skirting the San Jose hills to Canesha Park.

LOS ANGELES, CAL.—Immediate construction of the Los Angeles Pacific Railway Company's subway through the populous part of the city, giving rapid and direct service to Venice and Santa Monica, and the erection of a 12-story depot on Hill street, have been assured by the stockholders of the company. About $10,000,000 will be spent in the project. R. C. Gillis is president of the company.

LOS ANGELES, CAL.—Cars operated with electric storage batteries, the first west of New York, probably will be used on an electric railway to be constructed between Pedley Station, on the Santa Fe, and San Jacinto, a distance of 32 miles. Practically all rights of way for the line have been secured by Geo. I. Lamy, Central Building, who will organize a company, principally of Riverside people, to build and operate the road.

SAN FRANCISCO, CAL.—As a result of the visit here of Martin Kubierschky and Sidney H. March, first and second vice-presidents of the United Investment Railways Company, the holding company controlling the United Railroads of San Francisco, the powers of Attorney Joseph Redding, its legal representative in this city, are said to have been increased greatly, and this is taken to be the first actual move looking toward the retirement of Patrick Calhoun from the local field. Calhoun has long wanted to withdraw from the personal direction of the United Railroads. This desire has had its inspiration in the New York offices of the company, where it is felt that the extension of the properties under present conditions cannot be accomplished satisfactorily while the existing friction continues.

OAKLAND, CAL.—Action on the application of the San Francisco, Oakland and San Jose Consolidated Railway Co. for a franchise to 1000 feet of Oakland's water front, has been postponed by the wharves and water front committee in an effort to gain for the city the removal of the bulkhead line in what is known as the Key Route Basin to half or at least a quarter of a mile further out into the bay than it now exists. Under the application for a franchise, the city is granted a strip of land about 300 feet wide along the water front, which is considered inadequate for the needs of the municipality. With the removal of the bulkhead line further out into the bay, the city would gain thousands of acres of land of immense value by erecting its quay wall and filling in the intervening space. The change is protested by the railroad company.

WATERWORKS.

VALENTINE, TEXAS.—Thos. Dean of the Dean Manufacturing Company is installing a waterworks system at Valentine.

OAKLAND, CAL.—The bid of Cruikshank & Kollins of Pleasanton, to lay a pipe from Dougherty reservoir to the San Ramon road for $831 has been accepted.

ST. HELENS, ORE.—The St. Helens Water Commissioners have let the contract for the construction of the new St. Helens Water System to the McCabe Construction Company for $42,609.

VALLEJO, CAL.—At the suggestion of Commissioner Blake it has been decided to lay about 150 feet of two-inch water pipe along Georgia street just outside of the city limits. A four-inch main is to be laid to the limits.

SAN FRANCISCO, CAL.—The Board of Supervisors granted permission to the Aetna Mills to erect and maintain an engine and boiler of 100 h.p. in the premises situated on the northeast corner of Seventh and Berry streets for the purpose of furnishing power for a grist mill.

CORNING, CAL.—A notice has been filed in the office of the County Recorder by W. F. Luning to the effect that he has filed on 12,000 inches of water in Mill Creek to be used for generating electric power. A. D. Cutler of San Francisco has filed on 5000 inches of water at Hoodlum Chute, near Kirkwood, the water to be diverted by means of a pump.

OROVILLE, CAL.—Water rights that were a few years ago of little value are daily becoming exceedingly valuable and are frequent causes of expensive litigation in Butte and other counties of Northern California. The extensive use of these rights for hydro-electric power purposes is largely responsible for this state of affairs. In the Superior Court here the Pacific Gas & Electric Company secured a temporary injunction against the Oro Light & Power Company, a branch of the Steifer Mining Company, operating near Magalia, preventing it from using the waters of the west branch of Feather river for power purposes. The Steifer company is engaged in the construction of a dam in the west branch, and the power company claims that this dam will interfere with its water rights used for power development and for irrigation and domestic purposes in Oroville and vicinity. The Steifer dam is being built only a mile above that of the Oro Light & Power Company.

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JOURNAL OF ELECTRICITY
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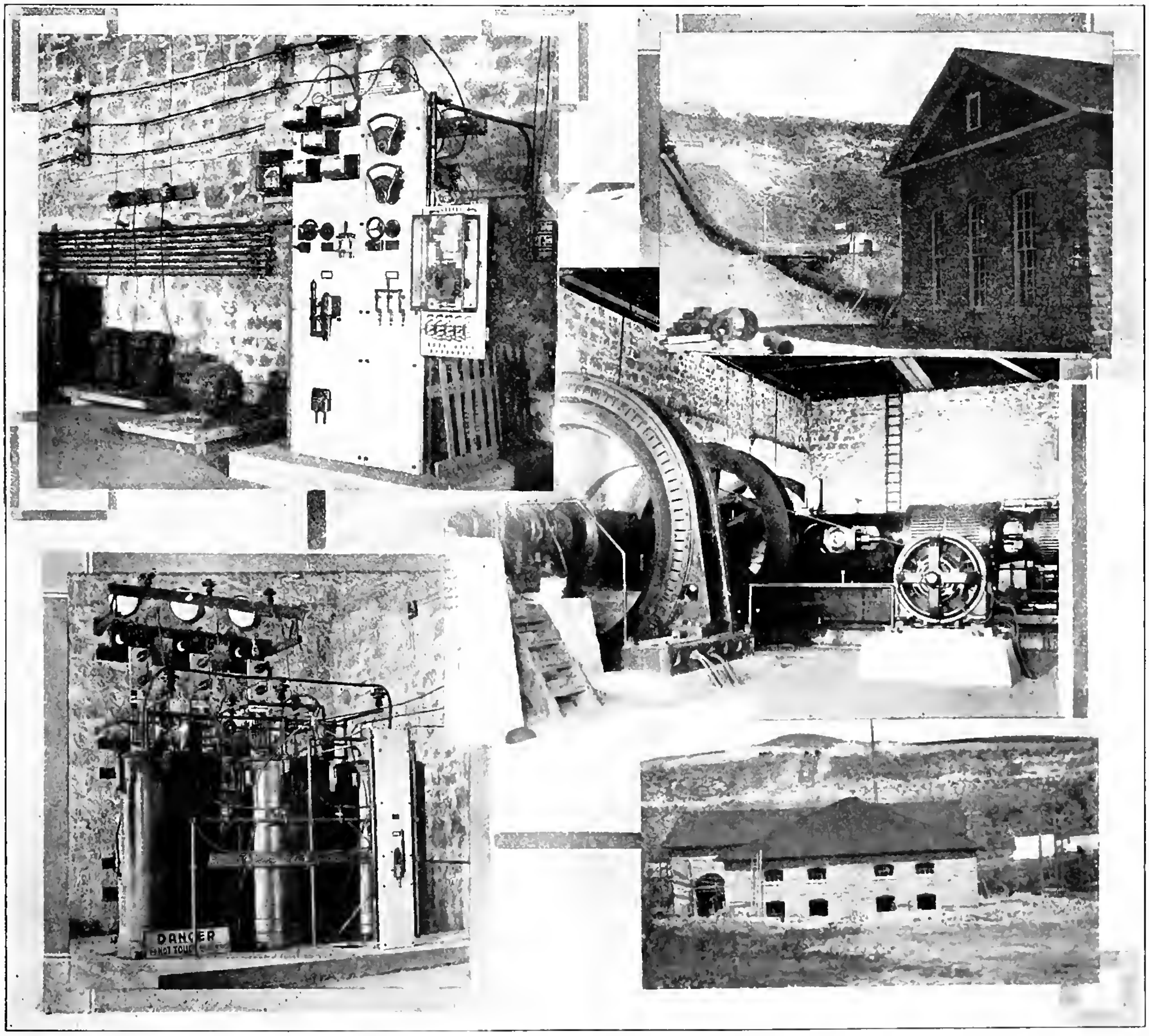
CHANGES IN NORTHWEST POWER COMPANIES



Plant of Yakima-Pasco Power Co. at Naches, Wash.

Important changes in the ownership of public utilities in the Pacific Northwest have taken place during the past few weeks with the result that the Northwestern Corporation which was organized in Portland last year to operate in Walla Walla, Pendleton, Lewiston, North Yakima, Corvallis, Eugene, Independence and several other towns has retired from business in these places and has turned its holdings over to eastern owners. The Strahorne properties in the Yakima Valley have also been sold to eastern people.

The gas and electric plants in Pendleton, Oregon, in Walla Walla, Washington, and the gas plant in

Lewiston, Idaho, together with the hydroelectric plant on the Walla Walla river in Oregon, steam station in Walla Walla and a transmission line about 50 miles long from Walla Walla through Milton, Freewater, Weston, Athena and Adams to Pendleton, all the Walla Walla Valley Railway Company of Portland. They formerly belonged to the Northwestern Corporation.

The street railway system in Walla Walla together with a 15-mile interurban line to Milton and Freewater, Oregon, are now owned and operated by the Walla Walla Railway Company of Portland. They formerly belonged to the Northwestern Corporation.

The gas plant in North Yakima, Washington which also belonged to the corporation, together with the two hydroelectric plants on the Yakima river, transmission lines and distributing systems in North Yakima, Kennewick, Pasco, Mabton, Sunnyside, Granger, Outlook, Kiona, and Richland, steam generating station in Kennewick and city water works in North Yakima, Kennewick and Pasco formerly owned by the two Strahorne companies of Spokane, the Northwest Light & Water Company and the Yakima Valley Power Company have been bought by the Yakima-Pasco Power Company.

The Columbia Power & Light Company, the Yakima-Pasco Power Company and the Walla Walla Valley Railway Company are all owned by the same people who control the Portland Gas & Coke Company and the Astoria Electric Company, and comprise an extensive list of public service properties, said to be the property of the American Power & Light Company of New York.

Guy W. Talbot, formerly vice-president and general manager of the Oregon Electric Railway, is president of the five American power and light local companies, N. A. Weathers is vice-president, Geo. F. Nevins, secretary and treasurer, and L. A. McArthur assistant secretary and treasurer. H. M. Papst is general manager of the Portland Gas & Coke Company; A. S. Grenier, general manager of the Columbia and Yakima companies, and C. S. Walters, general manager of the Walla Walla Valley Railway. Main offices are in Portland. General Manager Grenier has announced that a 66,000 volt line 45 miles long will be built immediately between Pasco and Walla Walla to connect the Columbia and Yakima companies. It has been unofficially announced in Portland that the Astoria, Columbia and Yakima companies will soon be consolidated into one permanent company. Efforts will be made to push the construction of high tension lines into all parts of central Washington and in the Walla Walla-Pendleton territory. The new owners have announced that they are in a position to furnish all the power needed in this section for domestic, manufacturing and pumping use, and will soon inaugurate a campaign for new business.

The H. M. Byllesby Company of Chicago has also opened offices in Portland, having assumed control of the Willamette Valley plants formerly owned by the Northwestern Corporation. Elmer Dover, formerly secretary to Mark Hanna has charge of the Portland office, and MacDonald Spencer, who has been connected with the General Electric Company for several years will be district manager at Eugene.

REPORT OF ELECTRICAL CONDITIONS AT OAKLAND, CALIFORNIA.[1]

BY KEMPSTER B. MILLER.

Electricity supplied to Oakland is derived mainly from the distant hydro-electric plants and high tension transmission lines of the Bay Counties Power Company, the Great Western Power Company and the Standard Electric Company. Current is sometimes supplied from the Martin gas engine plant south of San Francisco, and there is in one of the Oakland sub-stations a large steam turbo-generating unit. All electric power is distributed from two sub-stations at Grove and First streets and on Fifty-first street between Shattuck and Telegraph avenues.

The First street station, which is the principal distributing point for the city, contains the transformers and rotary converters for changing the high tension current supplied from distant outside points to suitable form for city distribution, and also a large steam turbo-electric unit intended as a reserve in case of interruption of the outside supply service or the inadequacy thereof. These two sub-stations are connected by tie feeders, so that each may in a certain measure relieve the other, and from them all of the primary circuits, suppliying current for power, heat and light for the entire area of Oakland and for some outlying districts, radiate.

The primary distribution circuits, leading from the sub-stations to the various portions of the city, are of four different types, as follows:

- 2300 volt alternating current three-phase, 60 cycle, 4-wire circuits.
- 4000 volt alternating current three-phase, 60 cycle, 3-wire circuits.
- 500 volt 2-wire direct current circuits.
- 7½ amp. alternating current, 60 cycle series arc light circuits.

The 2300 and 4000 volt alternating current circuits are for the general power and lighting purposes of the consumers and also for supplying current for the incandescent lamps in the ornamental posts or electroliers used in the down-town street lighting. The 500 volt direct current circuits are for strictly power purposes principally in the business district. The series arc lighting circuits are solely for the purpose of supplying current to the street arc lights.

The 2300 volt and 4000 volt alternating current primary circuits deliver their current to transformers scattered throughout the entire area of the city, these transformers being for the purpose of lowering the potential of the current delivered to them to a suitable voltage for use by the consumers.

The secondary circuits, which lead from the transformers mentioned above, are of two types:

(1) Three-wire alternating current circuits carrying a potential of approximately 220 and 440 volts.

(2) Three-wire alternating current circuits carrying a potential of approximately 110 and 220 volts.

The 220-440 volt secondary distribution circuits are for the purpose of supplying to the consumers throughout the entire city, except the central business area, current for general use for light, heat and power.

[1]Extracts from Report on Gas and Electrical Conditions in City of Oakland, California.

The 110-220 volt secondary distribution circuits supply mainly the general consumers in the down-town area and also the electrolier street-lighting system on the principal down-town streets.

The service rendered by this system may be divided broadly, for the purposes of this report, into two classes: that rendered to private consumers, and that to the public for street lighting. In the first of these classes the city, in so far as it uses electric light and power for its public buildings, schools, etc., may be considered in the nature of a private consumer.

The current supplied to most of the private consumers throughout the city for the general purposes of light, heat and power is alternating current at a pressure of 220 and 440 volts. This applies to all except those in the down-town area served by underground circuits. The current supplied to the general consumers in this latter portion of the city is of the same nature but at 110 and 220 volts.

The current supplied to those consumers using direct current apparatus for power purposes is direct current at 500 volts.

The public service for street lighting is of two classes, so far as this report is concerned: Arc lighting for street illumination and incandescent lighting for street illumination.

The arc lamps employed by the city for street illumination are scattered throughout the entire area of the city, except the down-town business portion and a few principal streets that are illuminated by incandescent lamps. These are lamps of alternating current inclosed type, consuming a constant current of 7½ amperes. The total number of arc lights so employed is 920.

The incandescent street lighting employed by the city is wholly by means of electroliers, each employing ten 16-cp. 110 volt incandescent lamps. These are used in the down-town area and in a few principal streets leading therefrom. The total number of electroliers so employed is 792.

Service Rendered to Private Consumers.

Under this broad heading I will consider first: whether the system is fundamentally of such a nature as to give the class of service that should be given, and second, whether the system, as it is, is rendering as good service as could be expected of one of its type.

The City of Oakland stands almost alone in this country in the fact that alternating current for general lighting and power purposes is supplied to the residences and small business places at approximately 220 volts pressure. The almost universal practice, where alternating current is employed, is to supply it for the purposes now under consideration at 110 volts or thereabouts.

The broad question therefore arises at once as to whether 220 volts is as desirable as 110 volts for general light and power purposes. I have no hesitation in saying that it is not, and the fact that approximately 110 volts has been adopted almost universally as a standard for this class of service in this country is in itself prima-facie evidence of the truth of this statement.

The considerations, upon which 220-volt alternating current service supplied to the consumers over circuits carrying 220-440 volts, are to be condemned are two-fold: First, considerations of the hazard to life and property; second, considerations of economy and general usefulness to the consumer.

Considered from the standpoint of the hazard to life and property, the 110-volt service has distinct advantages over the 220-volt. It is true that 220-volt shocks are seldom fatal, though they have been known to kill, but with the three-wire system of distribution employed in Oakland it is possible for a person to receive a shock of 440 volts. This constitutes a grave danger to the general consumer under existing conditions in Oakland.

In the 110-220 volt three-wire alternating current lighting systems that are used almost exclusively in this country, in order to properly safeguard consumers from injury or loss of life by shock, it is now recommended by all authorities, including the American Institute of Electrical Engineers, the National Electrical Code and the National Electric Light Association, that the lighting systems be grounded at the neutral point; that is, permanently connected to ground so that not more than 110 volts can exist between any wire of such circuits and the earth. This is to prevent the existence of higher voltages, due to accidental leakage from other high voltage wires in the street, and also to prevent the consumer from being subject to the full 220 volt potential which exists in a 110-220 volt system.

In the 220-440 volt system employed in Oakland, the neutral points in some of the circuits are grounded, while in others they are not. The grounding of this point in the 220-440 volt circuits is not safe, because it greatly increases the danger of the consumers receiving 220-volt shocks. The system is not safe when the neutral is left ungrounded, because, while the liability of receiving 220-volt shocks is somewhat less, there is increased liability of 440-volt shocks, which, of course, are much more serious. The only way, therefore, to make the system thoroughly safe is to change to 110-volt service, thus making it possible, with safety, to ground the neutral point as a protection against higher voltages without introducing a dangerous condition due to the grounding itself.

It is an indisputable fact that 110-volt service is safer from the standpoint of fire hazard than 220-volt service, although of course it is possible to safeguard either of these systems to such an extent as to make either acceptable from this standpoint.

A comparison between the two voltages from the standpoint of hazard to life and property must always result distinctly to the advantage of lower voltage.

The most important advantage of 110-volt service over 220-volt service from the standpoint of economy and general usefulness to the consumer is that the modern types of incandescent lamps, which seem destined to revolutionize the incandescent lighting industry, are not well adapted for 220-volt service except in light-giving units that are too large for the ordinary consumers' use; and even with the old carbon filament lamp, which is made available for 220 as well as for 110-volt service, he is forced to use a lamp of distinctly inferior efficiency.

Considering first the carbon filament incandescent lamp, the difference in efficiency between a 110 and a 220 volt lamp of equal candle power and equal life is approximately 15 per cent in favor of lamps of the lower

voltage. The consumer in paying his electric light bills is paying primarily for light, and if conditions imposed by the service force him to use less effective means for turning his current into light, then, at equal rate of charge for current, he is forced to pay more for his light. This is true whether he buys his own lamps or whether they are furnished by the company.

A still more important disadvantage of the 220-volt service appears when the possible use of the more modern metallic filament lamps is considered. The tungsten lamp, which in my opinion will practically supersede the 16-cp. carbon filament lamp, has at least 2½ times the light-giving power for the same consumption of electric energy as the carbon filament lamp. Not only are these lamps more efficient, but they give better light, and under most circumstances have longer life. The importance to the consumer of this new form of incandescent lamp is obviously great, but the consumer who has only 220-volt service at his command cannot avail himself of it except in very small measure, because the tungsten lamp and other metallic filament lamps are not well adapted for 220-volt service.

Small transformers have been devised for use at the consumers' premises to lower the voltage to a suitable value for these lamps. This is always accompanied by a loss of energy for which the consumer pays and may be considered only as an expedient.

It is true that there are certain types of lamps which operate to somewhat better advantage on 220-volt than 110-volt service. These types of lamp, however, have not proven their adaptability to the illuminating purposes of the small user in general and have not, and probably will not, come into very wide use among small consumers.

Heating appliances, whether for cooking or other purposes, domestic or industrial, are distinctly more durable and somewhat cheaper in first cost when adapted for 110-volt service than for 220. It is probable that this factor is not an important one now, owing to the relatively small use of such heating appliances in Oakland, but it will increase in importance as the use of these devices becomes more general, due to the public becoming educated to their use and to reduction in the cost of current to the consumer.

I will conclude this portion of my report by saying that the 220-440-volt system of distribution, as installed in Oakland, is much more dangerous to life and property than 110-220-volt service would be, and that it possesses distinct disadvantages from the standpoint of economy and general utility. For these reasons you are warranted in making a very strong effort to induce the operating company in Oakland to make the change from the 220-volt to the 110-volt service. In making such change, that company will be taking a step, which, in my opinion, its own self-interest will eventually force it to take.

Good electric light and power service demands that the consumer shall always have on the wires at his premises a voltage which does not vary materially from the nominal voltage, that is, from the voltage which the company agrees to furnish and for which the consumers' lamps and other current-consuming devices are best adapted.

Constancy of the voltage is of great importance, particularly from the standpoint of incandescent light service, since momentary fluctuations in the voltage cause wide fluctuations in the illuminating power of the lamp, rendering a light which is not only unsatisfactory, but may be injurious to the eyes. It is almost equally important that the constant voltage should be the nominal voltage which is agreed upon between the company and the consumer. A voltage that is materially below the agreed or nominal value will result in the lamps being worked at very low efficiency, the return in light not being at a fair rate for the amount of energy paid for. On the other hand, keeping the voltage materially above the nominal value works havoc with the life of the lamps adapted to the nominal voltage. Where, as in Oakland, the service is on the meter basis, the consumers' electric light bills are also increased by too high voltage, because his lamps consume more current at the higher voltage; but this apparent disadvantage is offset by the fact that at the higher voltage his lamps work at increased efficiency and thus give more light for the money expended for electricity.

The current which the operating company agrees to supply in Oakland is sixty-cycle current at 214 volts. The nominal voltage is therefore 214.

For the purposes of this report numerous tests of the voltage were made at various consumers' premises, located at widely distributed points throughout the city, so as to obtain values that may be considered representative for the entire city. The points at which these observations were made were so selected as to make possible the taking of observations on all of the circuits employed in the city, except in the comparatively small underground system, and on each phase of each circuit. These observations in each case consisted in making readings every five minutes throughout the two-hour period from approximately 8 to 10 p. m.; this period having been chosen because it represented the time at which the electric light service is most used by the average consumer at this season of the year.

These tests show the following facts: The average voltage for the two-hour period at the respective points of test ranged from 241.5 volts, as a maximum average, down to 220 volts, as a minimum average. Thus in all cases the average voltage at each point was higher than the nominal voltage by amounts ranging from 27.5 volts down to 6 volts. Expressed in percentage, the average voltage thus ranged from 12.9 per cent too high down to 2.8 per cent too high.

Without considering the constancy of the pressure supplied at any one consumer's premises, as shown by the readings taken from time to time during a period of observations, it is at once apparent that the supply of current to the consumers is at a voltage greatly in excess of the nominal 214 volts.

In justice to the company, it may be said that many of the customers are using poor lamps, which at the proper voltage would give insufficient illumination, and it may be that the present high voltage is maintained for the purpose of satisfying the customers in this respect. Regardless of what the motives of the company may be, however, this is not the way to give good electric light service. What should be done is for the company to maintain as closely as possible the voltage that it agrees to supply, thus working the

lamps of the consumers at the candle-power and efficiency for which they were intended.

I am informed that the incandescent lamps purchased by the city for use in public schools and buildings are 214-volt lamps and are, therefore, of a type corresponding exactly with the voltage which the company agrees to supply. On the other hand, it was noted that many of the private consumers were provided with lamps marked for 220 volts. The voltage supplied, ranging as it did from 216 volts to 244 volts, would average much too high for either of these two types of lamps, and many lamps, particularly those used by the city, showed evidence of being worked under excessive pressure. If the company is to continue its policy of maintaining its pressure materially higher than the nominal pressure, I would recommend that the city, instead of purchasing 214-volt lamps which correspond exactly with the nominal voltage, purchase 220-volt lamps, thus approaching more nearly the actual voltage supplied.

Considering now the constancy of the voltage supply, the maximum voltage observed at any point was 244, which is 30 volts or 14 per cent higher than the nominal. The minimum voltage observed at any point was 216, which is 2 volts or 9 per cent higher than the nominal. The maximum and minimum did not occur at the same premises.

The greatest variation noted at any one test point was from 235 volts to 218 volts, a variation of 17 volts or 7.8 per cent of the minimum. The smallest variation noted at any test point was from 240 volts, as a maximum, to 235 volts, as a minimum, a variation of 5 volts or 2.1 of the minimum.

A variation of only 5 volts would not be objectionable at any one station, provided the range was between the proper limits, but a variation of 17 volts would be too high under any circumstances. An analysis of the voltage readings taken during a two-hour period at some of the stations showing poor regulation, indicates in almost all cases that the voltage maintained was fairly constant for a period of about an hour, and then suddenly changed to another voltage, in all cases higher. This change occurred at about the hour of 9 o'clock and would seem to indicate a radical change at that time either in the loading of the circuits or in the source of supply. The moment-to-moment variation was not, therefore, quite as bad as would be indicated from the results given in the attached table, but this does not alter the fact that the variation is there and that in all cases the voltages are altogether too high in comparison with the nominal voltage.

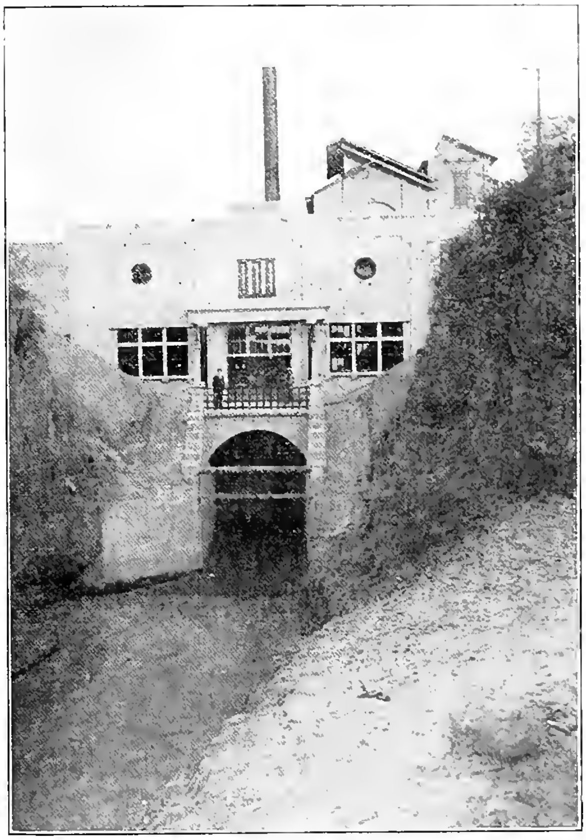
Concerning a proper requirement for the allowable variation of voltage at the consumer's premises, I will say that some companies aim at and practically attain a maximum variation of 2½ volts above and below the nominal pressure.

A 4700 foot dam with 4400 feet of spillway is being built across the Mississippi river at Keokuk, Iowa. The dam will be built of re-inforced concrete, with a height of 37 feet and a base of 43 feet. The water thus diverted will drive 30 turbine-units consisting of double waterwheels and generator. The ultimate development will be 200,000 h.p. for distribution throughout the Middle West the first transmission line being to St. Louis, a distance of 170 miles.

THE HOLTVILLE POWER COMPANY.

The Holtville Power Company operates a hydroeletric plant at Holtville in the Imperial Valley of California, which is said to be the only power plant below the level of the sea. Water is diverted from the main canal of the California Company three miles from Holtville. From the power company's ditch the water passes into a 50-in. wood stave pipe, 200 ft. long, which acts as a pen stock and gives a head of 76 ft. at the power house in the canyon of the Alamo river.

Recently a new concrete powerhouse has been completed, augmenting the 250 kw. Allis-Chalmers



Hydro-electric Plant of Holtville Power Company.

turbine and Bullock generator in the older brick powerhouse with a 350 and a 700 kw. unit of the same make. The transmission lines extend for eleven miles from Holtville to El Centro, radiating thence 10 miles to Calexico, 4 miles to Imperial and 11 miles to Brawley.

The auxiliary steam plant at El Centro is equipped with a 250 kw. generator driven by a St. Louis Corliss engine, supplied from Sterling boilers. This steam plant, also furnishes power for the ice and cold storage plant at El Centro with a production of forty-five tons of ice daily, and a storage capacity of 6000 tons. An additional 35-ton machine is now being installed.

An electric time recorder is used to determine the time and speed of flight in German air-ship competition. It consists of a recording clock connected by electric wires to the different observers who can record the time of the air ships passing by pushing a button thus actuating an electric magnetic marker in the clock. This together with a telephone system insures accuracy and prevents disputes.

HOW TO FIGURE COST OF ELECTRIC POWER.

BY S. V. WALTON.[1]

The purpose of the accompanying tables is to enable any one to determine by them the cost of any amount of electric power. Suppose, for example, A has a plant to be equipped, say, with a 75 h.p. motor. He wishes to operate, say, 12 hours a day. He learns that he can secure electric current,

He refers to the first table, and glances down the first column till he comes to 3 cents the kilowatt hour. Opposite that, in the next column, he sees 2.238 cents, which is the equivalent rate for one horsepower, since one horsepower equals 746 watts or .746 of one kilowatt. Then finding the column headed 12 and following it down to the line opposite the 3 cents of the first column he finds $10.95, which is the monthly cost, and opposite this, in the next column, is $131.40, which is the annual cost. Continuing on into the next column he finds $8.17, which is the monthly cost of one horsepower, and in the next column, just opposite, is $98.02, the yearly cost of one horsepower.

Multiplying these monthly and yearly horsepower costs by 75 he has the cost for his plant. Suppose now that he have his motor tested and find that it is taking only 60 horsepower. Then his power costs should be reduced accordingly, by figuring them at 60 horsepower instead of 75.

These tables save much figuring.

[1]Manager Commercial Department, Pacific Gas and Electric Company.

COST OF POWER (1 Full Month = 730 Hrs.) ①

Hrs per day		10				12				14				16				18				22				24			
Hrs per		Month 304		Year 3650		Month 365		Year 4380		Month 426		Year 5110		Month 487		Year 5840		Month 548		Year 6570		Month 669		Year 8030		Month 730		Year 8760	
Rate per K.W. hr cents	Rate per H.P. hr cents	Cost				Cost				Cost				Cost				Cost				Cost				Cost			
		K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year
.3	.224	.91	10.95	.68	8.17	1.10	13.14	.82	9.80	1.28	15.33	.95	11.44	1.46	17.52	1.09	13.07	1.64	19.71	1.23	14.70	2.01	24.09	1.50	17.97	2.19	26.28	1.63	19.60
.35	.261	1.06	12.78	.79	9.53	1.28	15.33	.95	11.44	1.49	17.89	1.11	13.34	1.70	20.44	1.27	15.25	1.92	23.00	1.43	17.15	2.34	28.11	1.75	20.97	2.55	30.66	1.91	22.87
.4	.298	1.22	14.60	.91	10.89	1.46	17.52	1.09	13.07	1.70	20.44	1.27	15.25	1.95	23.36	1.45	17.43	2.19	26.28	1.63	19.60	2.68	32.12	2.00	23.96	2.92	35.04	2.18	26.14
.45	.336	1.37	16.43	1.02	12.25	1.64	19.71	1.23	14.70	1.92	23.00	1.43	17.15	2.19	26.28	1.63	19.60	2.47	29.57	1.84	22.05	3.01	36.14	2.25	29.95	3.28	29.42	2.45	29.40
.5	.373	1.52	18.25	1.13	13.62	1.83	21.90	1.36	16.34	2.13	25.50	1.59	19.06	2.44	29.20	1.82	21.78	2.74	32.85	2.04	24.50	3.34	40.15	2.50	29.95	3.65	43.80	2.72	32.67
.55	.410	1.67	20.08	1.25	14.98	2.01	24.09	1.50	12.97	2.34	28.11	1.75	20.97	2.68	32.12	2.00	23.96	3.01	36.14	2.25	26.96	3.68	44.17	2.75	32.95	4.01	48.18	3.00	35.94
.6	.448	1.82	21.90	1.36	16.34	2.20	26.28	1.63	19.60	2.56	30.66	1.91	22.87	2.92	35.04	2.18	26.14	3.29	39.42	2.45	29.41	4.02	48.18	2.99	35.94	4.38	52.56	3.27	39.21
.65	.485	1.98	23.73	1.47	17.70	2.37	28.47	1.77	21.24	2.77	33.22	2.07	24.78	3.17	37.96	2.36	28.32	3.56	42.71	2.66	31.86	4.35	52.20	3.24	38.94	4.74	56.94	3.54	42.47
.7	.522	2.13	25.55	1.59	19.06	2.56	30.66	1.91	22.87	2.98	35.77	2.22	26.68	3.41	40.88	2.54	30.50	3.84	45.99	2.86	34.31	4.69	56.21	3.49	41.93	5.11	61.32	3.81	45.74
7¼	.541	2.20	26.46	1.64	19.74	2.65	31.76	1.97	23.69	3.09	37.05	2.30	27.64	3.53	42.34	2.63	31.58	3.97	47.63	2.96	35.53	4.85	58.22	3.62	43.43	5.29	63.51	3.95	47.38
.75	.560	2.28	27.38	1.70	20.42	2.74	32.85	2.04	24.50	3.20	38.33	2.38	28.59	3.65	43.80	2.72	32.67	4.11	49.28	3.07	36.76	5.02	60.23	3.74	44.93	5.48	65.70	4.08	45.01
7¾	.578	2.36	28.29	1.76	21.10	2.83	33.95	2.11	25.32	3.30	39.60	2.46	29.54	3.77	45.26	2.82	33.76	4.25	50.92	3.17	37.96	5.19	62.32	3.87	46.42	5.66	67.90	4.22	50.64
.8	.597	2.43	29.20	1.81	21.78	2.92	35.04	2.18	26.14	3.41	40.88	2.54	30.50	3.90	46.72	2.91	34.85	4.38	52.56	3.27	39.21	5.35	64.24	3.99	47.92	5.84	70.09	4.36	52.27
.85	.634	2.58	31.03	1.93	23.15	3.10	37.23	2.32	27.77	3.62	43.44	2.70	32.40	4.14	49.64	3.09	37.03	4.66	55.85	3.47	41.66	5.69	68.26	4.24	50.92	6.21	74.46	4.63	55.54
.9	.671	2.74	32.85	2.04	24.51	3.29	39.42	2.45	29.40	3.83	45.99	2.86	34.31	4.38	52.56	3.27	39.21	4.93	59.13	3.68	44.11	6.02	72.27	4.49	53.19	6.57	78.84	4.90	59.81
.95	.709	2.89	34.68	2.16	25.87	3.47	41.61	2.59	31.04	4.05	48.55	3.02	36.21	4.63	55.48	3.45	41.39	5.21	62.42	3.88	46.56	6.36	76.29	4.74	56.91	6.94	83.22	5.19	62.08
1.	.746	3.04	36.50	2.27	27.23	3.65	43.80	2.72	32.67	4.26	51.10	3.18	38.12	4.87	58.40	3.63	43.57	5.48	65.70	4.09	49.01	6.69	80.30	4.99	59.90	7.30	87.60	5.45	65.35
1.1	.821	3.34	40.15	2.50	29.95	4.02	48.18	3.00	35.94	4.69	56.20	3.50	41.93	5.36	64.24	4.00	47.93	6.03	72.27	4.50	53.91	7.36	88.35	5.49	65.89	8.03	96.36	5.99	71.88
1⅛	.839	3.42	41.06	2.55	30.63	4.11	49.28	3.06	36.76	4.79	57.49	3.58	42.89	5.48	65.70	4.09	49.01	6.17	73.81	4.60	55.14	7.53	90.34	5.62	67.39	8.21	98.55	6.13	73.40
1.2	.895	3.65	43.80	2.72	32.68	4.38	52.56	3.27	39.21	5.11	61.32	3.81	45.74	5.84	70.08	4.36	52.28	6.58	78.84	4.91	58.81	8.03	96.36	5.99	71.88	8.76	105.20	6.54	78.42
1¼	.932	3.80	45.63	2.83	34.04	4.56	54.75	3.40	40.84	5.33	63.88	3.97	47.65	6.09	73.00	4.54	54.46	6.85	82.13	5.11	61.26	8.36	100.38	6.24	74.88	9.13	109.50	6.81	81.69
1.3	.970	3.95	47.45	2.95	35.40	4.75	56.94	3.54	42.48	5.54	66.43	4.13	49.56	6.33	75.92	4.72	56.64	7.12	85.41	5.32	63.71	8.70	104.39	6.49	77.87	9.50	113.88	7.08	84.95
1.4	1.044	4.26	51.10	3.18	38.12	5.11	61.32	3.81	45.74	5.96	71.54	4.45	53.37	6.82	81.76	5.09	61.00	7.67	91.98	5.72	68.62	9.37	112.42	6.99	83.87	10.22	122.64	7.63	91.49
1.5	1.119	4.56	54.75	3.49	40.85	5.48	65.70	4.08	49.01	6.39	76.65	4.77	57.18	7.31	87.60	5.45	65.35	8.22	98.55	6.13	73.52	10.03	120.45	7.49	89.86	10.95	131.40	8.17	98.02
1.6	1.194	4.86	58.40	3.63	43.57	5.84	70.08	4.36	52.28	6.82	81.77	5.08	60.99	7.80	93.44	5.81	69.71	8.77	105.12	6.54	78.42	10.70	128.48	7.99	95.85	11.68	140.16	8.71	104.56
1.7	1.268	5.17	62.05	3.86	46.29	6.21	74.46	4.63	55.55	7.24	86.87	5.40	64.80	8.28	99.28	6.17	74.06	9.32	111.68	6.95	83.32	11.37	136.51	8.49	101.84	12.41	148.92	9.26	111.09
1¾	1.305	5.32	63.88	3.97	47.65	6.39	76.65	4.77	57.18	7.46	89.43	5.56	66.71	8.52	102.20	6.36	76.24	9.84	114.98	7.15	85.77	11.46	140.53	8.73	104.83	12.78	153.30	9.53	114.36
1.8	1.343	5.47	65.70	4.08	49.01	6.57	78.84	4.90	58.81	7.67	91.98	5.72	68.62	8.77	105.12	6.54	78.42	9.86	118.26	7.36	88.22	12.04	144.54	8.99	107.83	13.14	157.68	9.80	117.63
1.9	1.417	5.78	69.35	4.31	51.74	6.94	83.22	5.17	62.08	8.09	97.09	6.04	72.43	9.25	110.96	6.90	82.77	10.41	124.83	7.77	93.12	12.71	152.57	9.48	113.82	13.87	166.44	10.35	124.16
2	1.492	6.08	73.00	4.54	54.46	7.30	87.60	5.45	65.35	8.52	102.20	6.35	76.24	9.74	116.80	7.26	87.13	10.98	131.40	8.18	98.02	13.38	160.60	9.98	119.81	14.60	175.20	10.89	130.70
2.1	1.567	6.38	76.65	4.76	57.18	7.67	91.98	5.72	68.62	8.95	107.31	6.67	80.03	10.23	122.64	7.63	91.49	11.51	137.97	8.58	102.92	14.05	168.63	10.48	125.80	15.33	183.96	11.44	137.23
2.2	1.641	6.69	80.30	4.99	59.91	8.03	96.36	5.99	71.88	9.37	112.42	6.99	83.86	10.71	128.48	7.99	95.84	12.06	144.64	8.99	107.82	14.72	176.66	10.98	131.79	16.06	192.72	11.98	143.77
2¼	1.678	6.84	82.13	5.10	61.27	8.21	98.55	6.13	73.52	9.59	114.98	7.15	85.77	10.96	131.40	8.17	98.02	12.33	147.83	9.18	110.27	15.03	180.68	11.23	134.78	16.43	197.10	12.25	147.05
2.3	1.716	6.99	82.95	5.22	62.63	8.40	100.74	6.26	75.15	9.80	117.53	7.31	87.68	11.20	134.32	8.35	100.20	12.60	151.11	9.40	112.72	15.38	184.69	11.48	137.76	16.79	201.48	12.53	150.30
2⅜	1.772	7.22	86.65	5.39	64.67	8.67	104.03	6.47	77.60	10.12	121.36	7.55	90.54	11.57	138.70	8.63	103.47	13.02	156.04	9.71	116.40	15.89	190.71	11.86	142.27	17.34	208.05	12.93	155.20
2.4	1.790	7.30	87.60	5.44	65.35	8.76	105.12	6.54	78.42	10.22	122.64	7.62	91.49	11.69	140.16	8.72	104.55	13.15	157.68	9.81	117.63	16.05	192.72	11.98	143.77	17.52	210.24	13.07	156.84
2.5	1.865	7.60	91.25	5.67	68.08	9.13	109.50	6.81	81.69	10.65	127.75	7.94	95.30	12.18	146.00	9.08	108.91	13.70	164.25	10.22	122.53	16.72	200.75	12.48	149.76	18.25	219.00	13.62	163.37
2.6	1.940	7.90	94.90	5.90	70.80	9.49	113.88	7.08	84.95	11.08	132.86	8.26	99.11	12.66	151.84	9.44	113.27	14.25	170.82	10.63	127.43	17.39	208.78	12.98	155.75	18.98	227.76	14.16	169.90
2.7	2.014	8.21	98.55	6.12	73.52	9.86	118.26	7.35	88.22	11.50	137.97	8.58	102.92	13.15	157.68	9.81	117.63	14.80	177.39	11.04	132.33	18.05	216.81	13.48	161.74	19.71	236.52	14.70	176.44
2.8	2.089	8.51	102.20	6.35	76.24	10.22	122.64	7.62	91.49	11.93	143.08	8.90	106.74	13.64	163.52	10.17	121.98	15.34	183.96	11.45	137.23	18.73	224.84	13.98	167.73	20.44	245.28	15.25	182.97
2.9	2.163	8.82	105.85	6.58	78.97	10.59	127.02	7.90	94.16	12.35	148.19	9.21	110.55	14.12	169.36	10.53	126.34	15.89	190.53	11.86	142.13	19.40	232.87	14.47	173.72	21.17	254.04	15.19	189.51
3.	2.238	9.12	109.50	6.81	81.69	10.95	131.40	8.17	98.02	12.78	153.30	9.53	114.36	14.61	175.20	10.89	130.70	16.44	197.10	12.26	147.03	20.07	240.90	14.97	179.71	21.90	262.80	16.34	196.04

COST OF POWER (1 Full Month = 730 Hrs.) ②

Hrs per day		10				12				14				16				18				22				24			
Hrs per		Month 304		Year 3650		Month 365		Year 4380		Month 426		Year 5110		Month 487		Year 5840		Month 548		Year 6570		Month 669		Year 8030		Month 730		Year 8760	
Rate per K.W. hr cents	Rate per H.P. hr cents	Cost				Cost				Cost				Cost				Cost				Cost				Cost			
		K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year	K.W. Hrs per Month	Year	H.P. Hrs per Month	Year
3.1	2.313	9.42	113.16	7.03	84.41	11.32	135.78	8.44	101.29	13.21	158.41	9.85	118.17	15.10	181.04	11.26	135.05	16.99	203.67	12.67	151.93	20.74	248.93	15.47	185.70	22.63	271.56	16.88	202.58
3.2	2.387	9.73	116.80	7.26	87.14	11.68	140.16	8.71	104.56	13.63	163.52	10.17	121.98	15.58	186.88	11.62	139.41	17.54	210.24	13.08	156.83	21.41	256.96	15.97	191.69	23.36	280.32	17.43	209.11
3¼	2.424	9.88	118.63	7.37	88.50	11.86	142.35	8.85	106.18	13.85	166.09	10.33	123.89	15.83	189.80	11.80	141.59	17.81	213.53	13.29	159.24	21.74	260.98	16.22	194.69	23.73	284.70	17.70	212.38
3.3	2.462	10.03	120.45	7.49	89.86	12.05	144.54	8.99	107.82	14.06	168.63	10.48	125.80	16.07	192.72	11.98	143.77	18.08	216.81	13.49	161.73	22.07	264.95	16.47	197.68	24.09	289.08	17.97	215.66
3.4	2.536	10.34	124.10	7.71	92.58	12.41	148.92	9.26	111.09	14.48	173.74	10.80	129.61	16.56	198.56	12.35	148.12	18.63	223.39	13.90	166.64	22.74	273.02	16.97	203.67	24.82	297.84	18.52	222.18
3.5	2.611	10.64	127.75	7.94	95.31	12.78	153.30	9.53	114.36	14.91	178.85	11.12	133.42	17.05	204.40	12.71	152.49	19.18	229.95	14.31	171.54	23.41	281.05	17.47	209.66	25.55	306.60	19.06	228.72
3.6	2.686	10.94	131.40	8.17	98.03	13.14	157.68	9.80	117.63	15.34	183.96	11.44	137.23	17.53	210.24	13.08	156.84	19.73	236.52	14.72	176.44	24.08	289.08	17.97	215.65	26.28	315.36	19.61	235.25
3.7	2.760	11.25	135.05	8.39	100.75	13.51	162.06	10.08	120.89	15.76	189.07	11.76	141.04	18.02	216.08	13.44	161.19	20.28	203.09	15.13	181.34	24.75	297.11	18.47	221.64	27.01	384.12	20.15	241.75
3¾	2.797	11.40	136.88	8.51	102.11	13.69	164.25	10.21	122.53	15.98	191.63	11.91	142.95	18.26	219.00	13.62	163.37	20.55	246.38	15.33	183.79	25.08	301.13	18.72	224.64	27.38	328.50	20.42	245.06
3.8	2.835	11.55	138.70	8.62	103.47	13.87	166.44	10.35	124.16	16.19	194.18	12.07	144.86	18.51	221.92	13.80	165.55	20.82	249.66	15.53	186.24	25.42	305.14	18.97	227.63	27.74	332.88	20.70	248.32
3.9	2.909	11.86	142.35	8.85	106.20	14.24	170.82	10.62	127.43	16.61	199.29	12.38	148.67	18.99	227.76	14.16	169.91	21.37	256.23	15.94	191.14	26.09	313.17	19.47	233.62	28.47	341.64	21.24	254.86
4.	2.984	12.16	146.00	9.07	108.92	14.60	175.20	10.89	130.70	17.04	204.40	12.71	152.48	19.48	233.60	14.53	174.26	21.93	262.80	16.35	196.04	26.76	321.20	19.96	239.61	29.20	350.40	21.78	261.39
4.1	3.059	12.46	149.65	9.30	111.64	14.97	179.58	11.16	133.96	17.47	209.51	13.03	156.29	19.97	239.44	14.89	178.62	22.47	269.37	16.76	200.94	27.43	329.23	20.46	245.60	29.93	359.16	22.33	267.93
4.2	3.133	12.77	153.30	9.53	114.37	15.33	183.96	11.44	137.23	17.89	214.62	13.34	160.10	20.45	245.28	15.25	182.97	23.02	275.94	17.17	205.94	28.09	337.26	20.96	251.59	30.66	367.92	22.87	274.46
4¼	3.170	12.92	155.13	9.64	115.73	15.51	186.15	11.57	138.87	18.11	217.18	13.39	162.01	20.70	248.20	15.44	185.15	23.30	279.23	17.37	208.73	28.43	340.28	21.21	254.59	31.03	372.30	23.15	277.73
4.3	3.208	13.07	156.95	9.75	117.05	15.70	188.34	11.71	140.50	18.32	219.73	13.66	163.92	20.94	251.12	15.62	187.33	23.56	282.51	17.56	210.75	28.76	345.29	21.46	257.58	31.39	376.68	23.42	281.00
4.4	3.282	13.38	160.60	9.98	119.81	16.06	192.72	11.98	143.77	18.74	224.84	13.98	167.73	21.43	256.96	15.98	191.69	24.11	289.08	17.98	215.65	29.43	353.32	21.96	263.57	32.12	385.44	23.96	287.53
4.5	3.357	13.68	164.25	10.21	122.54	16.43	197.10	12.25	147.03	19.17	229.95	14.30	171.54	21.92	262.80	16.34	196.04	24.66	295.65	18.40	220.55	30.10	361.35	22.46	269.56	32.85	394.20	24.51	294.07
4.6	3.432	13.98	167.90	10.43	125.26	16.79	201.48	12.53	150.30	19.60	235.06	14.61	175.36	22.40	268.64	16.71	200.40	25.21	302.22	18.80	225.45	30.77	369.39	22.96	275.55	33.58	402.96	25.05	300.60
4.7	3.506	14.29	171.55	10.66	127.98	17.16	205.86	12.80	153.57	20.02	240.17	14.93	179.16	22.89	274.48	17.07	204.76	25.76	308.79	19.21	230.35	31.44	377.41	23.46	281.54	34.31	411.72	25.60	307.14
4¾	3.543	14.40	173.38	10.77	129.34	17.34	208.05	12.93	155.20	20.24	242.73	14.75	181.07	23.13	277.40	17.25	206.94	26.04	312.08	19.42	232.80	31.78	381.43	23.71	284.54	34.68	416.40	25.87	310.40
4.8	3.581	14.59	175.20	10.89	130.70	17.52	210.24	13.07	156.84	20.45	245.28	15.26	182.98	23.38	280.32	17.43	209.11	26.30	315.36	19.62	235.25	32.11	385.44	23.96	287.53	35.04	420.48	26.14	313.67
4.9	3.655	14.90	178.85	11.11	133.43	17.89	214.62	13.34	160.10	20.87	250.39	15.57	186.79	23.86	286.16	17.80	213.46	26.85	321.93	20.03	240.15	32.78	393.47	24.46	293.52	35.77	429.24	26.69	320.21
5.	3.730	15.20	182.50	11.34	136.15	18.25	219.00	13.62	163.37	21.30	255.50	15.89	190.60	24.35	292.00	18.16	217.83	27.40	328.50	20.44	245.06	33.45	401.50	24.96	299.52	36.50	438.00	27.23	326.74
5.1	3.805	15.50	186.15	11.57	138.87	18.62	223.38	13.89	166.64	21.73	260.61	16.20	194.41	24.84	297.84	18.52	222.18	27.96	335.07	20.85	249.96	34.11	409.53	25.45	305.51	37.23	446.76	27.77	333.27
5.2	3.879	15.81	189.80	11.79	141.60	18.98	227.76	14.16	169.90	22.15	265.72	16.52	198.22	25.32	303.68	18.89	226.54	28.50	341.64	21.26	254.86	34.78	417.56	25.95	311.50	37.96	455.52	28.32	339.81
5¼	3.916	15.06	191.63	11.91	142.96	19.16	229.95	14.30	171.54	22.37	268.28	16.07	200.13	25.57	306.60	19.07	228.72	28.77	344.55	21.46	257.31	35.12	421.58	26.20	314.45	38.33	459.90	28.59	343.08
5.3	3.954	16.11	193.45	12.02	143.32	19.35	232.14	14.43	173.17	22.58	270.83	16.84	202.03	25.81	309.52	19.25	230.90	29.04	348.21	21.67	259.76	35.45	425.59	26.45	317.49	38.69	464.28	28.86	346.34
5.4	4.028	16.42	197.10	12.25	147.04	19.71	236.52	14.70	176.44	23.00	275.94	17.16	205.85	26.30	315.36	19.61	235.25	29.59	354.78	22.08	264.66	36.12	433.62	26.95	323.48	39.42	473.04	29.41	352.88
5.5	4.103	16.72	200.75	12.48	149.77	20.08	240.90	14.98	179.71	23.43	281.05	17.47	209.66	26.79	321.20	19.98	239.61	30.14	361.35	22.48	269.56	36.79	441.65	27.45	329.47	40.15	481.80	29.95	359.41
5.6	4.178	17.02	204.40	12.70	152.48	20.44	245.28	15.25	182.97	23.86	286.16	17.79	213.47	27.27	327.04	20.34	243.97	30.69	367.92	22.89	274.46	37.46	449.68	27.95	335.46	40.88	490.56	30.50	365.95
5.7	4.252	17.33	208.05	12.93	155.21	20.81	249.66	15.52	186.24	24.28	291.27	18.11	217.28	27.76	332.88	20.70	248.32	31.24	374.49	23.30	279.36	38.13	457.71	28.45	341.45	41.61	499.32	31.04	372.43
5¾	4.289	17.48	209.88	13.04	156.57	20.99	251.85	15.66	187.88	24.50	293.83	18.26	219.19	28.00	335.80	20.88	250.50	31.51	377.78	23.51	281.81	38.46	461.73	28.70	344.44	41.98	503.70	31.31	375.75
5.8	4.327	17.63	211.70	13.16	157.93	21.17	254.04	15.79	189.51	24.71	296.38	18.43	221.10	28.25	338.72	21.07	252.68	31.78	381.06	23.71	284.26	38.80	465.74	28.95	347.44	42.34	508.08	31.59	379.02
5.9	4.401	17.94	215.35	13.38	160.60	21.54	258.42	16.07	192.78	25.13	301.49	18.74	224.91	28.73	344.56	21.43	257.03	32.33	387.63	24.12	289.16	39.47	473.77	29.45	353.43	[illegible]	516.84	32.13	385.59
6.	4.476	18.24	219.00	13.61	163.38	21.90	262.80	16.34	196.04	25.56	306.60	19.06	228.72	29.22	350.40	21.79	261.39	32.88	394.20	24.53	294.07	40.13	481.80	29.96	359.42	43.80	525.60	32.68	392.09
6.1	4.551	18.54	222.65	13.84	166.10	22.27	267.18	16.61	199.31	25.99	311.71	19.38	232.53	29.71	356.24	22.16	265.75	33.43	400.77	24.94	298.97	40.80	489.83	30.45	365.41	44.53	534.36	33.22	398.62
6.2	4.625	18.85	226.30	14.06	168.83	22.63	271.56	16.88	202.58	26.41	316.82	19.70	236.34	30.19	362.08	22.52	270.10	33.98	407.34	25.35	303.87	41.47	497.86	30.94	371.40	45.26	543.12	33.76	405.18
6¼	4.662	19.00	228.13	14.18	170.19	22.81	273.75	17.02	204.21	26.63	319.38	19.86	238.25	30.44	365.00	22.70	272.28	34.25	410.63	25.55	306.32	41.81	501.88	31.19	374.39	45.63	547.50	34.04	408.43
6.3	4.670	19.15	228.99	14.29	171.55	23.00	275.94	17.15	205.85	26.84	321.93	20.02	240.16	30.68	367.92	22.88	271.16	34.52	413.91	25.70	308.77	42.14	505.89	31.44	377.39	45.99	551.88	34.31	411.69
6.4	4.774	19.46	233.60	14.52	174.27	23.36	280.32	17.43	209.11	27.26	327.04	20.33	243.97	31.17	373.76	23.25	278.92	35.07	420.48	26.16	313.67	42.81	513.92	31.94	383.38	46.72	560.64	34.85	418.23
6.5	4.849	19.76	237.25	14.74	177.00	23.73	284.70	17.70	212.38	27.69	332.15	20.65	247.76	31.66	379.60	23.61	283.17	35.62	427.05	26.57	318.57	43.48	521.95	32.44	389.37	47.45	569.40	35.40	424.76

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.

The following papers have been announced for presentation at the coming convention of the Association of Railway Telegraph Superintendents, to be held at Los Angeles, Cal., June 20, 21, 22, 23 and 24.

"Wireless Telegraphy," by William Maver, Jr.

"Education for Efficient Railroad Service," by D. C. Buell.

"Protecting Telephone Lines from Lightning and Other Disturbances," by M. E. Launbranch.

"Automatic Block and Highway Crossing Signaling," by H. P. Ryner.

"Telephone Train Dispatching," by E. E. Dildine.

"Testing of Telegraph and Telephone Circuits," by V. E. Kissinger.

"Telephoning to and from Trains," by E. P. Griffith.

"Composite Telephone Blocking," by W. F. Williams.

Several matters of importance will be discussed at the executive sessions, and a fine program of entertainments is being provided.

COST OF POWER. (1 FULL MONTH = 730 HRS.)

Hrs. per day		10				12				14				16				18				22				24			
Hrs. per		Month 304	Year 3650			Month 365	Year 4380			Month 426	Year 5110			Month 487	Year 5840			Month 548	Year 6570			Month 669	Year 8030			Month 730	Year 8760		
Rate per KW hr	Rate per HP hr	Cost				Cost				Cost				Cost				Cost				Cost				Cost			
		KW hrs. per		HP hrs. per		KW hrs. per		HP hrs. per		KW hrs. per		HP hrs. per		KW hrs. per		HP hrs. per		KW hrs. per		HP hrs. per		KW hrs. per		HP hrs. per		KW hrs. per		HP hrs. per	
Cents	Cents	Month	Year	Month	Year	Month	Year	Month	Year	Month	Year	Month	Year	Month	Year	Month	Year	Month	Year	Month	Year	Month	Year	Month	Year	Month	Year	Month	Year
6.6	4.924	20.06	240.90	14.97	179.72	24.09	289.08	17.97	215.65	28.12	337.20	20.97	251.59	32.14	385.44	23.97	287.53	36.17	433.63	26.98	323.47	44.15	529.98	32.94	395.34	48.18	578.16	35.94	431.30
6.7	4.998	20.37	244.55	15.20	182.44	24.46	293.46	18.24	218.92	28.54	342.37	21.29	255.40	32.63	391.28	24.34	291.59	36.72	440.19	27.30	328.37	44.82	538.01	33.44	401.35	48.89	586.92	36.49	438.83
6¾	5.035	20.52	246.38	15.31	183.80	24.64	295.65	18.38	220.55	28.76	344.93	21.46	257.31	32.87	394.20	24.52	294.04	36.99	443.48	27.59	330.92	45.15	542.03	33.65	404.39	49.28	591.30	36.76	441.10
6.8	5.073	20.67	248.20	15.42	185.16	24.82	297.84	18.52	222.18	28.97	347.48	21.60	259.22	33.12	397.12	24.70	296.24	37.26	446.76	27.80	333.27	45.49	546.04	33.94	407.34	49.64	595.68	37.03	444.37
6.9	5.147	20.98	251.85	15.65	187.85	25.19	302.22	18.79	225.45	29.35	352.59	21.92	263.05	33.60	402.96	25.06	300.60	37.81	453.33	28.21	338.18	46.16	554.07	34.44	413.33	50.37	604.44	37.58	450.96
7.0	5.222	21.28	255.50	15.88	190.61	25.55	306.60	19.06	228.72	29.82	357.70	22.24	266.84	34.09	408.80	25.42	304.96	38.36	459.90	28.62	343.00	46.82	562.10	34.94	419.32	51.10	613.20	38.12	457.44
7.1	5.297	21.58	259.15	16.10	193.35	25.92	310.98	19.33	231.99	30.25	362.91	22.56	270.65	34.58	414.64	25.79	309.31	38.91	466.47	29.03	347.98	47.50	570.13	35.44	425.31	51.83	621.96	38.67	463.94
7.2	5.371	21.89	262.80	16.33	196.06	26.28	315.36	19.61	235.25	30.67	367.92	22.87	274.46	35.06	420.48	26.15	313.67	39.46	473.04	29.43	352.88	48.16	578.16	35.94	431.30	52.56	630.72	39.21	470.51
7¼	5.408	22.04	264.63	16.44	197.42	26.46	317.55	19.74	236.89	30.89	370.48	23.03	276.37	35.31	423.40	26.33	315.85	39.73	476.35	29.64	355.33	48.50	582.18	36.19	434.30	52.93	635.10	39.48	473.71
7.3	5.446	22.19	266.45	16.56	198.78	26.65	319.74	19.88	238.52	31.10	373.03	23.19	278.28	35.55	426.32	26.51	318.03	40.00	479.61	29.84	357.78	48.83	586.19	36.43	437.29	53.29	639.48	39.76	477.04
7.4	5.520	22.50	270.10	16.78	201.50	27.01	324.12	20.15	241.79	31.52	378.14	23.51	282.09	36.04	432.16	26.88	322.38	40.55	486.18	30.25	362.68	49.50	594.22	36.93	443.28	54.02	648.24	40.30	483.57
7.5	5.595	22.80	273.75	17.01	204.23	27.38	328.50	20.42	245.06	31.95	383.25	23.83	285.90	36.53	438.00	27.24	326.74	41.10	492.75	30.66	367.58	50.17	602.25	37.43	449.27	54.75	657.00	40.85	490.11
7.6	5.670	23.10	277.40	17.24	206.95	27.74	332.88	20.70	248.33	32.38	388.36	24.15	289.71	37.01	443.84	27.60	331.09	41.65	499.32	31.07	372.48	50.84	610.28	37.93	455.26	55.48	665.76	41.39	496.64
7.7	5.744	23.41	281.05	17.46	209.67	28.11	337.26	20.97	251.59	32.80	393.47	24.46	293.53	37.50	449.68	27.97	335.45	42.20	505.89	31.48	377.38	51.51	618.31	38.43	461.25	56.21	674.52	41.93	503.18
7¾	5.781	23.56	282.88	17.58	211.03	28.29	339.45	21.10	253.22	33.02	396.03	24.62	295.43	37.74	452.60	28.15	337.63	42.47	509.18	31.68	379.83	51.84	622.33	38.68	464.25	56.58	678.90	42.21	506.45
7.8	5.819	23.71	284.70	17.69	212.39	28.47	341.64	21.24	254.86	33.23	398.58	24.78	297.34	37.99	455.52	28.33	339.81	42.74	512.46	31.89	382.29	52.18	626.34	38.93	467.24	56.94	683.28	42.48	509.71
7.9	5.893	24.02	288.35	17.92	215.12	28.84	346.02	21.51	258.12	33.65	403.69	25.10	301.15	38.47	461.36	28.69	344.16	43.29	519.03	32.30	387.19	52.84	634.37	39.43	473.23	57.67	692.04	43.02	516.25
8.0	5.968	24.32	292.00	18.14	217.84	29.20	350.40	21.78	261.39	34.08	408.80	25.42	304.96	38.96	467.20	29.06	348.52	43.84	525.60	32.70	392.09	53.51	642.40	39.93	479.22	58.40	700.80	43.57	522.78
8.1	6.043	24.62	295.65	18.37	220.56	29.57	354.78	22.06	264.66	34.51	413.91	25.73	308.77	39.45	473.04	29.42	352.88	44.39	532.17	33.11	396.99	54.18	650.43	40.43	485.21	59.13	709.56	44.11	529.32
8.2	6.117	24.93	299.30	18.60	223.29	29.93	359.16	22.33	267.93	34.93	419.02	26.05	312.58	39.93	478.88	29.78	357.23	44.94	538.74	33.52	401.86	54.85	658.46	40.93	491.20	59.86	718.32	44.66	535.85
8¼	6.154	25.08	301.13	18.71	224.65	30.11	361.35	22.47	269.56	35.15	421.58	26.21	314.45	40.18	481.80	29.96	359.41	45.21	542.03	33.73	404.34	55.18	662.48	41.18	494.20	60.23	722.70	44.93	539.12
8.3	6.192	25.23	302.95	18.83	226.01	30.30	363.54	22.60	271.19	35.36	424.13	26.37	316.40	40.42	484.72	30.15	361.59	45.48	545.31	33.93	406.79	55.52	666.49	41.43	497.20	60.59	727.08	45.20	542.39
8.4	6.266	25.54	306.60	19.05	228.73	30.66	367.92	22.87	274.46	35.78	429.24	26.69	320.21	40.91	490.56	30.51	365.95	46.03	551.88	34.34	411.69	56.19	674.52	41.92	503.19	61.32	735.84	45.75	548.92
8.5	6.341	25.84	310.25	19.28	231.46	31.03	372.30	23.19	277.73	36.21	434.35	27.00	324.02	41.40	496.40	30.87	370.30	46.58	558.45	34.75	416.59	56.86	682.55	42.42	509.18	62.05	744.60	46.29	555.46
8.6	6.416	26.14	313.90	19.51	234.18	31.39	376.68	23.42	281.00	36.64	439.46	27.32	327.83	41.88	502.24	31.24	374.66	47.13	565.02	35.15	421.49	57.53	690.58	42.92	515.17	62.78	753.36	46.84	561.99
8.7	6.490	26.45	317.55	19.73	236.91	31.76	381.06	23.69	284.26	37.06	444.57	27.64	331.64	42.37	508.08	31.60	379.02	47.68	571.59	35.57	426.40	58.20	698.61	43.42	521.16	63.51	762.12	47.38	568.53
8¾	6.527	26.60	319.38	19.85	238.26	31.94	383.25	23.83	285.89	37.28	447.13	27.80	333.55	42.61	511.00	31.78	381.19	47.95	574.88	35.77	428.85	58.53	702.63	43.67	524.15	63.88	766.50	47.65	571.80
8.8	6.565	26.75	321.20	19.96	239.62	32.12	385.44	23.96	287.53	37.49	449.68	27.96	335.46	42.86	513.92	31.96	383.37	48.22	578.16	35.98	431.30	58.87	706.64	43.92	527.15	64.24	770.88	47.92	575.06
8.9	6.630	27.06	324.85	20.19	242.35	32.49	389.82	24.24	290.80	37.91	454.79	28.28	339.27	43.34	519.76	32.32	387.73	48.77	584.73	36.38	436.20	59.53	714.67	44.42	533.14	64.97	779.64	48.47	581.60
9.0	6.714	27.36	328.50	20.41	245.07	32.85	394.20	24.51	294.07	38.34	459.90	28.59	343.08	43.83	525.60	32.69	392.09	49.32	591.30	36.79	441.10	60.21	722.70	44.92	539.13	65.70	788.40	49.01	588.13
9.1	6.789	27.66	332.15	20.64	247.79	33.22	398.58	24.78	297.33	38.77	465.01	28.91	346.89	44.32	531.44	33.05	396.44	49.87	597.87	37.20	446.00	60.87	730.73	45.42	545.12	66.43	797.16	49.56	594.67
9.2	6.865	27.97	335.80	20.87	250.52	33.58	402.96	25.05	300.60	39.19	470.12	29.23	350.70	44.80	537.28	33.41	400.80	50.42	604.44	37.61	450.90	61.54	738.76	45.92	551.11	67.16	805.92	50.10	601.20
9¼	6.900	28.12	337.63	20.98	251.88	33.76	405.15	25.19	302.23	39.41	472.68	29.39	352.61	45.05	540.20	33.60	402.98	50.69	607.73	37.81	453.35	61.87	742.78	46.17	554.10	67.53	810.30	50.38	604.47
9.3	6.938	28.27	339.45	21.09	253.24	33.95	407.34	25.32	303.87	39.62	475.23	29.55	354.52	45.29	543.12	33.78	405.15	50.96	611.01	38.02	455.80	62.21	746.79	46.42	557.10	67.89	814.68	50.65	607.74
9.4	7.012	28.58	343.10	21.32	255.96	34.31	411.72	25.60	307.14	40.04	480.34	29.86	358.33	45.78	548.96	34.14	409.51	51.51	617.58	38.43	460.70	62.88	754.82	46.92	563.09	68.62	823.44	51.19	614.27
9.5	7.087	28.88	346.75	21.55	258.69	34.68	416.10	25.87	310.40	40.47	485.45	30.18	362.14	46.27	554.80	34.50	413.87	52.06	624.15	38.84	465.60	63.55	762.85	47.41	569.08	69.35	832.20	51.74	620.81
9.6	7.162	29.18	350.40	21.77	261.41	35.04	420.48	26.14	313.67	40.90	490.56	30.50	365.95	46.75	560.64	34.87	418.22	52.61	630.72	39.25	470.51	64.22	770.88	47.91	575.07	70.08	840.96	52.28	627.34
9.7	7.236	29.49	354.05	22.00	264.13	35.41	424.86	26.41	316.94	41.32	495.67	30.82	369.76	47.24	566.48	35.23	422.57	53.16	637.29	39.65	475.41	64.88	778.91	48.41	581.06	70.81	849.72	52.83	633.88
9¾	7.273	29.64	355.88	22.11	265.49	35.59	427.05	26.55	318.56	41.54	498.23	30.98	371.67	47.48	569.40	35.41	424.76	53.43	640.58	39.86	477.86	65.22	782.93	48.66	584.05	71.18	854.10	53.10	637.14
9.8	7.311	29.79	357.70	22.23	266.85	35.77	429.24	26.68	320.21	41.75	500.78	31.13	373.58	47.73	572.32	35.59	426.94	53.70	643.86	40.06	480.31	65.55	786.94	48.91	587.05	71.54	858.48	53.37	640.41
9.9	7.385	30.10	361.35	22.45	269.58	36.14	433.62	26.96	323.47	42.17	505.89	31.45	377.39	48.21	578.16	35.96	431.29	54.25	650.43	40.47	485.21	66.22	794.97	49.41	593.04	72.27	867.24	53.92	646.95
10.0	7.460	30.40	365.00	22.68	272.30	36.50	438.00	27.23	326.74	42.60	511.00	31.77	381.20	48.70	584.00	36.32	435.65	54.80	657.00	40.88	490.11	66.89	803.00	49.91	599.03	73.00	876.00	54.46	653.48

as a basis for determining the most economical power source.

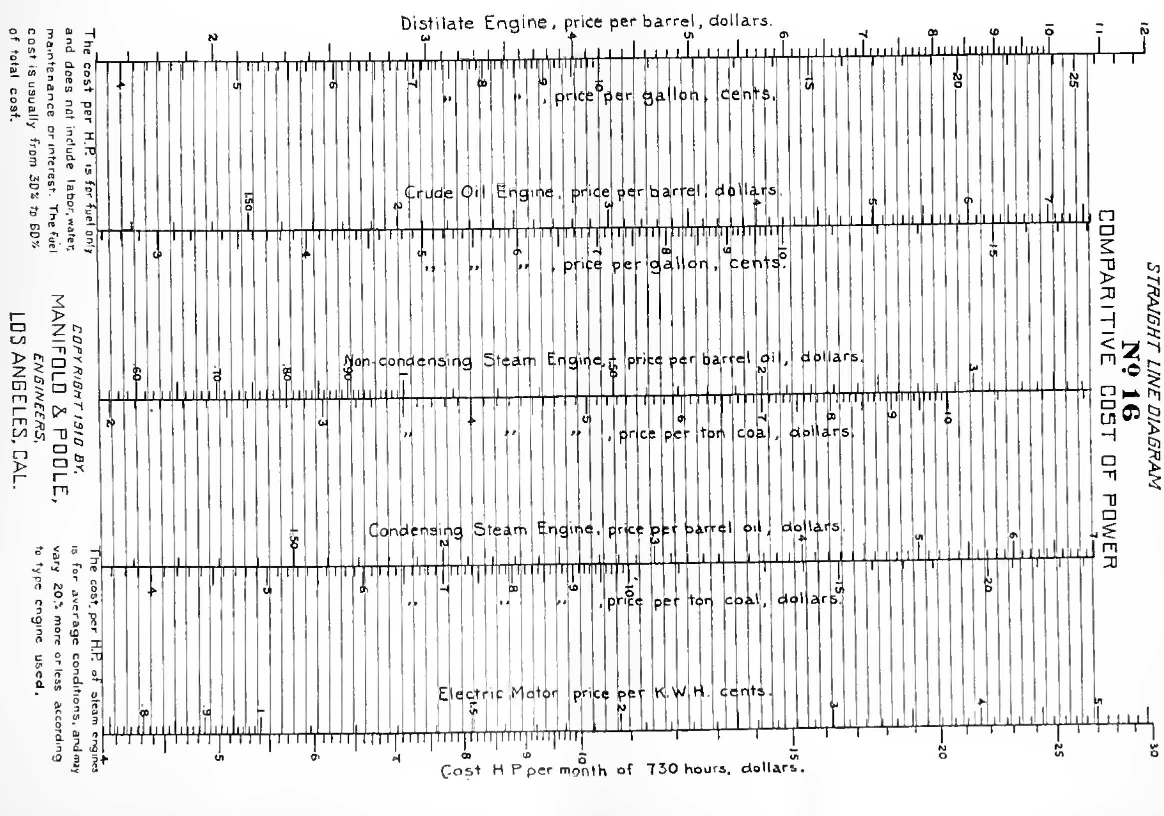
As will be noted from the diagram comparison is made between a distillate engine, a crude oil engine, a non-condensing steam engine, a condensing steam engine and an electric motor at various prices for fuel or electricity. These costs do not include labor, water, maintenance, depreciation or interest, being for fuel only. The figures are based on average conditions for Pacific Coast practice.

Corresponding costs may be found along the same horizontal line. For instance we find that the power developed by a distillate engine with gasoline at 5 cents per gallon is equivalent to that developed by a crude oil engine with oil at $1.47 per barrel or 3½c per gallon, to that of a non-condensing steam engine with coal at $2.58 per ton or to an electric motor with power at .93 cent per kw. hr.

COMPARATIVE COST OF POWER.

In connection with the accompanying tables showing the cost of electric power we publish, by permission, from Manifold & Poole's "Straight Line Engineering Diagrams," one of a new set of ten which has recently been added to this collection. This diagram gives a graphic representation of the comparative cost of power from different prime movers and may be used

The diagram also shows the relative fuel values of coal and of oil and the relation between barrels and gallons of oil. Other uses will suggest themselves to the reader who will find it a convenient means of conversion and comparison. While its values are necessarily approximate they give a rough and ready method for field use which can be checked when more complete data is available in the office.



SELECTING WATER-POWER SITES BY CLAIRVOYANCE.

BY RUSSELL L. DUNN.

"Water-power sites" are not natural things. When they exist at all they are artificial things. They happen as results of a selection, corresponding to a fabrication, made with intention to accomplish particular desired commercial results.

Comprehensively, a "water-power site" is the surface of the land on which are emplaced all of the fabricated water works which turn or divert water from the situs of its natural fall, described commonly as flow, and on the selected artificial situs convert that fall into that physical form of energy which we describe as work.

In detail, the fabricated waterworks may include as items, all, or only a part of:

1. Dams (one or several) placed in the bed of the natural channels of water flow.

2. Canal, ditch, flume, or pipe, (one or several), conduits for the water.

3. Reservoir (one or several) conduits for the water.

4. Penstock (one or several) conduits for the water and at the same time part of the engine for converting the fall of the water into work.

5. Power house (one or several) sheltering the more obvious parts of the engine for converting the fall of the water into work, and water-wheels, air compressors and electric generators.

6. Power transmission conduit (one or several); poles, pulleys and cables or ropes for transmission of direct water-power (work), poles and wires for transmission of work as electric power, and pipes for transmission of work as compressed air power.

The indispensable items are "penstock" and "power transmission conduit." The "penstock" may be emplaced in the natural situs of the water flow and be itself arranged as an air compressor which will automatically convert part of the fall of the water into "work." A "pipe line" to conduct the compressed air will make the work commercially available as "compressed air power." Any engineer will immediately think of particular plans for the conversion of the fall of water into work from which one or more of the above mentioned items will be missing.

Practically, the particular fabricated waterworks of the above items are first determined from commercial considerations, are planned to produce a desired commercial result from the marketing or commercial use of "work" (which is commonly spoken of as power) and the situs of their emplacement, the selection of the land on which they would be fabricated, comes last.

The theory of "conservation of water-power sites," which was invented for ex-President Roosevelt by Mr. Gifford Pinchot and by their strenuous advocacy has become a political issue, has obviously assumed that the order of construction of a water-power business is just the opposite—that the situs of emplacement of waterworks is invariably natural and exclusive, that the situs is definable or ascertainable from an examination of the land surface, and that the situs is selected in advance of planning the waterworks and in advance of desiring any particular commercial result from the marketing of work as one or other commercial form of water-power. This is the theory of the Pickett bill under consideration by Congress, which provides for public land withdrawals in blocks on the assumption that in advance of any determined commercial result desired by anybody Federal bureau officials can select and classify the parcels of public land from the blocks which will thereafter be the situs of emplacement for any waterworks which may thereafter be planned to produce particular commercial results for someone.

Now the practical fact of the matter being that the situs of emplacement is selected after the particular fabrication of waterworks is planned, the latter only being planned after a particular commercial result from the marketing of a particular form of water-power has been conceived as desirable, it follows, therefore: that unless Federal bureau officials charged with the duty of classifying "water-power sites" from the public land have the clairvoyant knowledge with which to forsee the future, to forsee what particular commercial result from water-power manufacture will be conceived sometime by someone as desirable, and to foresee the particular waterworks fabrication which will then be planned—unless they have this power of second sight to read the future before it comes—they will certainly be unable to select now the situs of emplacement of waterworks which have not even been conceived—that is pick out particular parcels of public land which will be, **not are**, "water-power sites."

It is of course conceivable that Federal bureau officials will be able to select land which can be used for the emplacement of waterworks of their planning to produce a commercial result which they may conceive as desirable, but, for the moment going a step further—assume the government selection made and a price or conditions named by the government for the use of the selection, immediately thereupon the government selection becomes competitively considered with other sites and that site is ultimately adopted which produces the best commercial result quite regardless of whether or not it is the government selection or not.

Illustrating this, there may be taken the U. S. Geological Survey topographic atlas sheets of any western source of water supply with the public land survey lines platted on it. No matter what selection of 40-acre parcels of land may be made as a governmental "water-power site" for that source of water supply, it will still be possible to make an entirely independent selection which would be a possible site for waterworks utilizing the same water supply. The fact is that for almost every western source of water supply there are possible not one, but several, plans of waterworks which would make it available for power manufacture, and not one, but several water-power sites.

Any selection or classification of public land as "water-power sites" is a mere pretense unless it contemplates selecting or classifying all the public land as "water-power sites" which may by any possible planning of disposition of waterworks become the situs of any of them. If this be done it means the indefinite withdrawal from settlement or other disposal of about all the remaining public land fit for settlement situated in the western states. After a water-power site

is commercially selected from it, the other land reserved pending this commercial selection may or may not become available for settlement and other disposal. It is quite conceivable that even after a commercial selection has been made it may be abandoned and another selection made which might take advantage of the premature disposal of the other land.

It is indisputable that if there be selected all of the 40-acre parcels of public land which touch the natural channels of water flow, then the Federel government will have land some of which must be used as part of the situs of waterworks for power manufacture. The public land so reserved by selection would hardly be describable as water-power sites, however. It would operate to fence in water owned by the states very much as the commercial device termed a "spite fence" encloses the plot of a land owner so that he cannot get full use and full value out of his property.

If the Federal government were to go about getting what some of its administrative officials seem to want in this direct mode, there would be no reason for the withdrawal of public land in blocks as proposed by the Pickett bill. It would only be necessary to amend the existing public land laws by providing that there should be reserved from disposal any 40-acre tract traversed by or bordering on any natural water flow. Then the United States spider could sit in the midst of the web absolntely sure that the private flies would be caught when they come to get water. But, this would only happen when all the land bordering on water flows is public land, a condition quite unusual in any of the states, although usual in some of the territorial possessions. In the states where much land bordering on water flows having convertible falls is already private land, the withdrawal must include practically all the public land which is worth anything for settlement as well as what public land there is on the water courses.

Much has been made in yellow print of what has already been accomplished by Federal bureau officials in so-called saving to the people of "water-power sites." If the particular instances be examined in detail it will appear that in no case has anything been accomplished by the selective initiative of Federal bureau officials in defining "water-power sites." Every case has been a case of initiative by private persons who have planned particular fabrications of waterworks for particular commercial results of their own conception. It has happened that some of the situs of emplacement proposed is public land. The Federal bureau officials being advised of this selection have thereupon selected the same parcels of public land as "water-power sites," and by preventing the use of these parcels for the situs of the planned structures except on their own arbitrary conditions claim that they have saved them for the people.

Owens river as a source of water supply for power manufacture has already furnished three instances which illustrate what has just been stated. In two the entire fabrication of waterworks proper is on private land, only a part of the situs of emplacement of the pole and wire line conduit for electric power happens to be public land. Further, the public land is desert in character, unavailable for settlement except as mining causes temporary settlement. There being no color of law at the time for Federal bureau interference with the appropriation of a pole and wire line easement on desert public land, the Federal bureau officials selected from this public land parcels covering a barren mountain range on which there was a scattered nut pine growth of absolutely no economic value except as a temporary source of fuel for mining, and officially declared it a national forest. A few miles of pole and wire electric power conduit being unavoidably within this "faked" national forest the Federal Forestry bureau declared (in effect) the situs of this line within the faked national forest a "water-power site" and proceeded to prevent its use except on impossible conditions which were not acceded to. The saving to the people accomplished by the Forestry bureau officials has been the shutting out of one of the two enterprises from its intended market, the mines of Goldfield, and the needless creation of a monopoly of power business in Goldfield and Tonopah for the other enterprise.

The third instance is the power manufacturing enterprise of the City of Los Angeles in which the entire fabrication of waterworks is on private land except parts of the canal and pipe line conduit of the water which in this case will be used in a power house 180 miles distant from the natural source of the water. The "water-power site" on the public land in this instance consists of a part of the situs of the water conduit. The location of the situs has been changed as the actual fabrication of the water condnit has progressed. The entire location is the result of private initiative.

Now the point of mentioning these instances is this. Ten years back in time neither Goldfield nor Tonopah existed, nor had the idea been conceived of Los Angeles manufacturing water-power from the use of Owens river by the absolute creation of an artificial fall for its water 180 miles away from the river. How then conld Federal bureau officials have selected ten years ago the public land parcels from block withdrawals which are now, to employ their own descriptive term, "water-power sites" of Owens river, California? Could they have done it ten years ago had then Chief Forester Pinchot given his young assistants the advantage of a college education at public expense in the black art of "clairvoyance" as well as a college education in forest culture and rain-making? If Federal bureau officials could not have looked into the crystal ten years ago and there and then seen the "water-power sites" which are to-day, how then shall they today look into the crystal and see in the withdrawn blocks of public land the "water-power sites" of the next century's making? "Pish!" with apology to Omar Khayam, "Ex-Chief-Forester Pinchot is a good fellow. He means well."

Regulation of Niagara's power development is provided in a treaty recently signed by the United States and Great Britain. The Canadian side is to be permitted the use of 36,000 cubic feet per second, while the New York side will be allowed to use 20,000 cubic feet per second. The Canadian allotment will make possible a much larger development than is now in use, but as the developing companies are permitted by the Canadian authorities, as well as by the United States authorities, to transmit and sell in the United States at least half of the power generated in Canada, the New York side is benefited by the Canadian development.

POWER DEVELOPMENT IN THE PUGET SOUND COUNTRY.[1]

Industrial development always follows the line of least resistance. The localities that attain pre-eminence in industry are those which are rich in transportation facilities, in varied natural resources, and in the means of generating power. A locality may become great through the possession of two, or even one, of these characteristics; but ideal conditions are found only when the three are combined. The Puget Sound country is industrially in its infancy: though it has already acquired large stature, its growth is insignificant in comparison with that for which all its conditions are preparing it. It has hydroelectric potentialities many times in excess of its present industrial activity; it has raw materials suitable for manufacturing on the greatest scale; and nowhere in either hemisphere are there better facilities for transportation.

There is no mistaking the conclusion to be drawn from the fact that the population of Seattle has increased from 80,000 in 1900 to approximately 300,000 in 1910, or that Tacoma has in the same period grown from less than 38,000 to 125,000. Such figures can mean but one thing; they indicate the birth throes of cities of the first magnitude. These great and rapidly growing Puget Sound cities have a significance that is possessed by almost every American city of size; that is, they signify a surrounding country rich either in natural resources or in industrial activity. These particular cities represent both great natural resources and rapid strides in their industrial development.

It was no longer ago than 1853 that the State of Washington was part of the Territory of Oregon. In those days there were no more than a handful of people there. Today there are practically a million and a half; and by far the greater part of this growth has fallen within the last two decades. When one notes such an extensive movement of population as this, it is perfectly safe to infer industrial opportunities of the first order. These opportunities have been sufficiently developed in the last decade or two for their real character to be seen. The magnificent forests of Washington have been productive of a vast lumber industry, and have made the rapidly growing city of Everett the most important point on earth for the export of shingles. The climate is such that agriculture is here pursued under the most advantageous conditions. In the Puget Sound country are vast deposits of coal, and although these are hardly at the beginning of their development, Washington is annually mining 3,000,000 tons of coal. Much of the bituminous coal here found is of excellent coking character, a fact of importance in view of the iron deposits of which this region is possessed. Though the metals have not been among the leading causes of the present prosperity of Washington, the industry has not been neglected; the mines of the State are producing gold, silver, lead, copper, quicksilver, zinc, arsenic, antimony, molybdenum, nickel, cobalt, tungsten, titanium, bismuth, sulphur, selenium, tellurium, tin and platinum. Mention should also be made of the fisheries; its salmon canneries have carried the name of the bustling manufacturing city of Bellingham far and wide.

Here we have the raw materials of a great industrial community. To these must be added the vast transportation facilities with which the State has been and still is being equipped in order to make effective the opportunities for commerce afforded by the peculiar coast line of Puget Sound. And for the most successful exploitation of all these resources and facilities, the State of Washington is endowed with hydroelectric potentialities of a character to stamp this region as "the most fertile field for power development in the United States."

The purpose of this article is to dwell on certain features of the power situation in that part of the Pacific Northwest commonly known as the Puget Sound Country. This district comprises the territory lying between the Olympic and Cascade mountains, its chief physical feature being the great island sea known as the Puget Sound. The shore of this body of water exceeds 2000 miles and is broken by numerous bays and harbors, upon which are located Seattle, Tacoma, Everett and Bellingham. This country possesses a most equable climate, mild in winter and cool in summer. Its natural resources are multifold, and to their development may be traced the rise of that long chain of prosperous cities and thriving towns which have made "Puget Sound" a familiar phrase in two hemispheres—Bellingham with its 40,000 population, Everett with 36,000, Seattle with 300,000 and Tacoma with 125,000. Here we find lumbering conducted on a most extensive scale; and here, on the deforested lands, agriculture has for years been appealing to the marvelous tide of immigration that has characterized the State of Washington, and in particular that form of agriculture from which such large profits are today derived—fruit growing. Here mines of every description are being developed, and fisheries whose products travel as far east as the Atlantic seaboard. Those three concomitants of successful manufactures—materials, power, transportation—are all here, with the inevitable result of a great and rapidly increasing industrial activity. And here foreign commerce has grown to such proportions that Seattle is now contesting the first place on the Pacific with San Francisco.

Two streams particularly available for supplying hydroelectric power to this region are the Snoqualmie and White rivers. Of the two plants here mentioned, the Snoqualmie river has been harnessed for a number of years. It is owned and operated by the Seattle-Tacoma Power Co. The Pacific Coast Power Co. is the possesor of certain land and water rights essential to the development of power on the White river, within twenty miles of Seattle and fifteen miles of Tacoma. This company is preparing for an ultimate development of 80,000 horsepower from the White river, with a first development, at present under construction, of about 27,000 horsepower. The Snoqualmie plant has now 14,000 developed horsepower, and the development of 9000 additional horsepower is nearing completion. This power is distributed in Everett, Seattle and Tacoma. So rapid, however, is the increase in the demand in these cities and the surrounding country that the development of the water rights on the White river has become a matter of urgent necessity.

Water is to be diverted from White river into a storage basin of about 2,436,570,000 cubic feet capacity,

[1]Public Service Journal.

including the sheet known as Lake Tapps, and delivered at the turbine water wheels in the generating station on Stuck river, through steel penstocks under a head of 415 feet. The initial development will be about 27,000 horsepower, but the dam, canal, reservoir and forebay will be constructed to take care of the ultimate capacity of the plant, namely, in excess of 80,000 horsepower. Owing to the latter fact, the company will be able to make its future increases in generating capacity at a very reasonable cost.

That increases will be called for in the very near future, is beyond all doubt. The initial development of 27,000 horsepower will be completed by the fall of 1911, but this whole amount is in a fair way to be immediately absorbed, and the presumption is irresistable that an increase in generating capacity must follow without delay.

The condition in which the Pacific Coast Power Company finds itself, is, in fact, a very striking indication of the growth of community life in the Northwest, and particularly in the Puget Sound country. Empire building in that section of the United States is proceeding at a pace that precludes any rest on the part of those whose function it is to provide public utilities. In common parlance much is said about providing facilities for the future; as a matter of fact, the work of providing facilities for the present is taxing every energy.

CENSUS FIGURES ON ELECTRIC POWER.

According to the figures of the Bureau of the Census in 1902 the annual output of all electric stations and electric railways in the United States amounted to 4,768,535,512 kilowatt hours. In 1907 the output of the two classes of stations was 10,621,406,837 kilowatt hours, the increase in that year as compared with 1902 being 5,852,871,325 kilowatt hours, or 122.7 per cent. In 1902 the output by electric railways formed 47.4 per cent of the total, but by 1907 the proportion for such railways had fallen to 44.9 per cent.

The number of commercial and municipal plants increased from 3620 in 1902 to 4714 in 1907. the increase amounting to 1094 or 30.2 per cent. The application of the same rate of increase to the estimated number of isolated plants in 1902 gives an estimate of 65,000 for 1907. To what extent the utilization of surplus power in the operation of private electric plants to furnish light and power for large mills, department stores, hotels and other industrial enterprises has stimulated the increase in these plants it is, the report declares, impossible to state, and notice is given that the estimate, therefore, may be more or less than the actual number of isolated plants in existence.

Referring to power or generating plants, the report states that the number of primary power of generating plants was not called for in the schedule used for reporting central stations in 1907, but some idea of their number may be had from the fact that the returns showed 4731 plants equipped with dynamos for the generation of electricity. Of the 4,714 stations reported in 1907, 227 had no generating equipment, while 113 had more than one power plant. This latter class reported 357 generating stations.

There were, in 1907, according to the report, upward of 30,000 individuals, companies, corporations, and municipalities, exclusive of isolated electric plants, which reported the generation or utilization of electric current in what may be termed "commercial enterprises."

These industries represent an outstanding capitalization of $6,209,746,753, of which amount $1,367,338,-836 is credited to central electric stations—$3,774,722,-096 to electric railways, $814,616,004 to commercial or mutual telephone companies, and $253,019,817 to telegraph companies, the latter item including $32,726,242, the capital stock of wireless telegraph companies. The capitalization of the 17,702 independent farmer or rural telephone lines and of the 1157 electric police-patrol and fire-alarm systems could not be ascertained.

With regard to street railways, it was found in 1907 that car mileage had increased 41.4 per cent; there was a gain of 63.3 per cent in the total number of passengers; a rise of 55.9 per cent in the number of fare passengers; the number of companies increased 25.2 per cent; the trackage lengthened by 52.4 per cent; the gross income of the railways jumped 71.6 per cent; the amount of salaries and wages kept upward pace with the rest; and electricity practically superseded all other kinds of motive power.

CHINESE PIG FOR IRONDALE FURNACES.

In reporting the signing of a contract for the supply of Chinese pig iron and iron ore to an American concern by the Hanyang Iron and Steel Works, of Hankow, Vice-Consul Hubert G. Baugh gives the following details:

The contract calls for the shipment to the Western Steel Corporation, at Irondale, Washington, of at least 36,000 tons each of pig iron and iron ore annually for 15 years. At the option of the purchaser the shipments may be increased to 100,000 tons in a year. This Chinese ore is guaranteed 62 per cent pure, and the pig iron from it was quoted last December at $25 per ton, against $23 to $24.50 for English and Continental.

The total output of pig iron of the Hanyang works for 1909 was 74,000 tons. A new blast furnace to be started shortly will enable this to be doubled, but if the possible maximum of 100,000 tons is desired by the American Steel Company it can readily be seen that the larger part of the output of the Hanyang works will be exported. Exports to Shanghai and other Chinese ports amounted in 1909 to 16,800 tons, to Japan 23,700, to the United States 3800, a total of 44,300 tons.

The Robert Dollar Steamship Company will transport the ore and pig iron, and at least 12 trips a year will be necessary to carry the minimum amount. For this service one or two new steamers will immediately be constructed in the British Isles. Though these will fly the British flag they will be owned by American capitalists. It will require considerable freight to fill these vessels in the outward cargo, and this enterprise should help increase trade between the United States and China. The proposed trip next September of representatives of the Associated Chambers of Commerce of the Pacific Coast should further stimulate this commerce.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

(Continued.)

CHAPTER VIII.

REPRESENTATIVE SCHEDULES OF RATES.

The Commonwealth Edison Co., of Chicago, Ill.

Schedule A.—Regular Lighting Rate.

The following is the regular rate for electricity for lighting purposes, or upon an interior distributing circuit carrying electricity for lighting and also for heating or power through the same meter, as measured by a meter or meters owned and installed by the company:

Thirteen cents (13c) per kilowatt hour for all electricity consumed in each month up to and including an amount that would be equal to thirty hours' use of the consumer's maximum demand in such month, and seven cents (7c) per kilowatt hour for all electricity consumed in such month in excess of that amount.

Maximum recording meters will be installed by the company for the purpose of ascertaining the maximum demand, except where the capacity of the consumer's installation is less than one kilowatt, in which case the maximum demand will be estimated.

A discount of one cent per kilowatt hour on the consumer's total monthly consumption will be allowed on monthly bills paid on or before ten days after their respective dates.

The rate stated in this schedule A covers and includes, for incandescent lighting, the free installation and use of the proper supply of incandescent lamps of the company's present standard carbon filament types, and of the same voltage, efficiency and candlepower as the incandescent lamps now furnished by the company.

An abatement or reduction of one-half cent (½c.) per kilowatt-hour from the aforesaid rate shall be allowed to a consumer furnishing, maintaining and renewing all the lamps or other forms of electric illuminants used by him.

Schedule B.—Regular Power Rate.

The following is the regular rate for electricity used for power purposes exclusively, as measured by a meter or meters owned and installed by the company:

Eleven cents (11c) per kilowatt hour for all electricity consumed in each month up to and including an amount that would be equal to thirty hours' use of the consumer's maximum demand in such month; and six cents (6c) per kilowatt hour for all electricity consumed in such month in excess of that amount.

When the electricity is taken from the company's direct current system, the greatest number of kilowatts used at one time (the peak of the load) in any month shall be deemed the maximum demand for such month; and maximum recording meters will be furnished by the company for the purpose of ascertaining the maximum demand, except where the capacity of the consumer's installation is less than one kilowatt, in which case the maximum demand will be estimated.

When the electricity is taken from the company's alternating current system, the maximum demand for any month shall be the number of kilowatts equal to a percentage of the total kilowatt capacity represented by all motors connected, which percentage shall be in accordance with the following table of percentages:

Where installations are under 10 horsepower, and only one motor is used 85%

Where installations are under 10 horsepower, and more than one motor is used 75%

Where installations are from 10 horsepower to 50 horsepower, both inclusive (irrespective of number of motors) 65%

Where installations are over 50 horsepower (irrespective of number of motors) 55%

The horsepower capacity of any alternating current motor or motors shall be assumed to be that which is indicated by the manufacturer's standard nominal rating or ratings; and each horsepower shall be deemed to be equal to seven hundred and forty-six watts. The company shall, however, have the right ,from time to time, to test any such motor or motors, and if it be found on any such test that the actual horsepower used by such motor or motors exceeds its or their rated capacity, the kilowatt equivalent of the maximum horsepower actually used shall constitute the consumer's maximum demand.

A discount of one cent (1c.) per kilowatt-hour on the consumer's total monthly consumption will be allowed on monthly bills paid on or before ten days after their respective dates.

The consumer shall pay to the company each month not less than fifty cents (50c.) per horsepower, or fraction thereof, in rated capacity of motor or motors connected.

Schedule C.—Wholesale Rates for Electricity.

Any consumer entering into a written contract to use the company's electricity for either lighting or power, or both, for a period of not less than five years in any single premises occupied by him, will, at his option, be given a wholesale rate for such premises, in lieu of the rates stated in Schedules A and D, which wholesale rate shall consist of both a primary and a secondary charge in accordance with the following specification of charges:

Direct Current.—Contract Without Guaranty.

Primary Charges.

For Each Month:

$3.20 per kilowatt of the consumer's maximum demand in such month up to and including 20 kilowatts.

$2.50 per kilowatt of the excess of the consumer's maximum demand in such month over 20 and up to and including 50 kilowatts.

$2.20 per kilowatt of the excess of the consumer's maximum demand in such month over 50 kilowatts.

Secondary Charges.

For Each Month:

6c per kilowatt-hour for the consumption in such month up to and including 2000 kilowatt hours.

3c per kilowatt-hour for the excess consumption in such month over 2000 and up to and including 5000 kilowatt hours.

1.4c per kilowatt-hour for the excess consumption in such month over 5000 kilowatt-hours.

Contract with Guaranty.

If the consumer will guarantee that his maximum demand in each year of the contract term shall be not less than 200 kilowatts, the following primary and secondary charges will be made:

Primary Charges.

$28.00 per kilowatt per year reckoned upon 200 kilowatts, the guaranteed maximum demand; and

$25.00 per kilowatt per year for the excess, if any, over 200 kilowatts of the consumer's actual maximum demand recorded in the year.

Such primary charges for each year to be paid by the consumer in installments as follows:

At the end of each month he shall pay $2.33 1-3 per kilowatt reckoned upon 200 kilowatts, and $2.08 1-3 per kilowatt for the excess, if any, over 200 kilowatts of the maximum demand recorded in the year previously to that time.

At the end of the year he shall pay the difference, if any, between the sum of the prescribed monthly installments for the year, and the amount constituting the full primary charge for the year.

Secondary Charges.

For Each Month:

6c per kilowatt-hour for consumption in such month up to and including 2000 kilowatt-hours.

3c per kilowatt-hour for the excess consumption in such month over 2000 and up to and including 5000 kilowatt-hours.

1.4c per kilowatt-hour for the excess consumption in such month over 5000 kilowatt-hours.

Alternating Current Transformed.—Contract Without Guaranty.

Primary Charges.

For Each Month:

$3.20 per kilowatt of the consumer's maximum demand in such month up to and including 20 kilowatts.

$2.20 per kilowatt of the excess of the consumer's maximum demand in such month over 20 and up to and including 50 kilowatts.

$2.00 per kilowatt of the excess of the consumer's maximum demand in such month over 50 kilowatts.

Secondary Charges.

For Each Month:

6c per kilowatt-hour for the consumption in such month up to and including 2000 kilowatt-hours.

3c per kilowatt-hour for the excess consumption in such month over 2000 and up to and including 5000 kilowatt-hours.

1.1c per kilowatt-hour for the excess consumption in such month over 5000 and up to and including 30,000 kilowatt-hours.

.9c per kilowatt-hour for the excess consumption in such month over 30,000 kilowatt-hours.

Contract With Guaranty.

If the consumer will guarantee that his maximum demand in each year of the contract term shall be not less than 200 kilowatts, the following primary and secondary charges will be made:

Primary Charges.

$26.00 per kilowatt per year reckoned upon 200 kilowatts, the guaranteed maximum demand; and

$21.50 per kilowatt per year for the excess, if any, over 200 kilowatts of the consumer's actual maximum demand recorded in the year.

Such primary charges for each year to be paid by the consumer in installments as follows:

At the end of each month he shall pay $2.16 2-3 per kilowatt reckoned upon 200 kilowatts, and $1.75 1-6 per kilowatt for the excess, if any, over 200 kilowatts of the maximum demand recorded in the year previously to that time.

At the end of the year he shall pay the difference, if any, between the sum of the prescribed monthly installments for the year, and the amount constituting the full primary charge for the year.

Secondary Charges.

For Each Month:

6c per kilowatt for the consumption in such month up to and including 2000 kilowatt-hours.

3c per kilowatt-hour for the excess consumption in such month over 2000 and up to and including 5000 kilowatt-hours.

1.1c per kilowatt-hour for the excess consumption in such month over 5000 and up to and including 30,000 kilowatt hours.

.9c per kilowatt-hour for the excess consumption in such month over 30,000 kilowatt hours.

Alternating Current Untransformed.—Contract With Guaranty.

If the consumer will guarantee that his maximum demand in each year of the contract term shall be not less than 200 kilowatts, the following primary and secondary charges will be made:

Primary Charges.

$25.00 per kilowatt per year reckoned upon 200 kilowatts, the guaranteed maximum demand; and

$20.50 per kilowatt per year for the excess, if any, over 200 kilowatts of the consumer's actual maximum demand recorded in the year.

Such primary charges for each year to be paid by the consumer in installments as follows:

At the end of each month he shall pay $2.08 1-3 per kilowatt reckoned upon 200 kilowatts, and $1.70 5-6 per kilowatt for the excess, if any, over 200 kilowatts of the maximum demand recorded in the year previously to that time.

At the end of the year he shall pay the difference, if any, between the sum of the prescribed monthly installments for the year, and the amount constituting the full primary charge for the year.

Secondary Charges.

For Each Month:

6c per kilowatt-hour for the consumption in such month up to and including 2000 kilowatt-hours.

2.7c per kilowatt-hour for the excess consumption in such month over 2000 and up to and including 5000 kilowatt-hours.

1c per kilowatt-hour for the excess consumption in such month over 5000 and up to and including 30,000 kilowatt hours.

.8c per kilowatt-hour for the excess consumption in such month over 30,000 kilowatt-hours.

Bills for both primary and secondary charges will be rendered monthly and a discount of ten per cent. (10%) upon the secondary charges will be allowed on all bills paid on or before ten days after their respective dates.

Schedule U.—Automobile Charging in Private Garages.

The rate for electricity for charging automobiles in private garages is either the regular power rate specified in Schedule B, or the power rate under contract for one year or longer specified in Schedule D as the consumer may prefer, subject, however, to the following additional provisions:

The net minimum charge to be paid by the consumer each month shall be not less than sixty-six and two-thirds cents (66 2-3c) for each kilowatt of the consumer's maximum demand in such month, and no monthly bill shall be less than one dollar and fifty cents ($1.50). Where alternating current charging boards are used no monthly bill shall be less than one dollar and fifty cents ($1.50) for each charging board.

Schedule V.—Automobile Charging in Public Garages.

The rate for electricity for charging automobiles in public garages is either the regular power rate specified in Schedule B, or the power rate under contract for one year or longer, specified in Schedule D, as the consumer may prefer, subject, however, to the following additional privisions:

If the consumer agrees not to make use of the company's service for this purpose during the two hours of the day between four and six o'clock P. M., his net rate for electricity

furnished for charging automobiles shall not exceed five cents (5c.) per kilowatt-hour.

Where alternating current charging boards are used no monthly bill shall be less than one dollar and fifty cents ($1.50) for each charging board.

Schedule W.—Rates for "Throw-Over" Switch Service.

Where a consumer's premises are supplied with electricity either for light or power, or both, from some plant in the building in which the premises are situated (whether such plant belongs to the consumer or not), and such consumer desires to be in a position to use, or in fact uses, the company's electrical service, not regularly but only occasionally and during the temporary break-down or cessation of such plant; or where a consumer's premises are supplied with power of any kind from any plant in the building in which the premises are situated (whether such plant be an electric plant or not, or be owned by the consumer or not), and such consumer desires to be in a position to use, or in fact uses, the company's electrical power service, not regularly but only occasionally and during the temporary bread-down or cessation of such plant, the consumer will be charged and must pay to the company for such emergency service the rate hereinafter in this schedule provided, to-wit:

Such rate will be that specified in Schedule A. D. or E, according to the purpose for which the service is used, with the additional requirement that the consumer shall pay, irrespective of the amount of his consumption, a minimum monthly charge depending upon the number and capacity of lamps, motors and other apparatus arranged for connection with the company's service, which charge shall be in accordance with the following table of minimum charges:

For each incandescent lamp so connected, ten cents (10c) per month where the lamp has a capacity of fifty (50) watts or less, at rated voltage, and at the rate of ten cents (10c) per month for fifty (50) watts of capacity where the lamp has a capacity exceeding fifty (50) watts.

For each arc lamp so connected one dollar ($1.00) per month where the lamp has a capacity of five hundred (500) watts or less, at rated voltage, and at the rate of one dollar ($1.00) per month for five hundred (500) watts of capacity where the lamp has a capacity exceeding five hundred (500) watts.

For each motor so connected, other than a motor used for operating elevators, hoists or similar machinery, one dollar and fifty cents ($1.50) per month per rated horsepower of such motor.

For each motor so connected used for operating elevators, hoists or similar machinery, five dollars ($5.00) per month per rated horsepower of such motor.

The company will furnish emergency service under this schedule only when the premises are situated on its existing lines having the requisite capacity, and only when the consumer signs a contract for the service, running for one year or longer and specifying the number and capacity of lamps, motors or other electrical apparatus in his premises that are to be supplied with the company's electricity during such occasional periods and providing that the consumer shall so arrange his wiring that no lamps, motors or apparatus other than those specified in the contract can be thrown on the company's service by means of switches, or otherwise. For the purpose of this service the company will enter its service main into the building in which the consumer's premises are situated (providing the consumer, in case he shall not own the building, shall obtain the necessary consent from the owner), and the consumer must, at his own expense, install switches and such other equipment as may be necessary for connecting his premises with such service main at the point of entry into the building. For service under this schedule the company will not furnish lamps or renewals for the same.

(To be continued.)

HISTORY OF THE STOCKTON WATER COMPANY.

BY J. W. HALL,

The growth of the Stockton waterworks, now owned by the Pacific Gas and Electric Company, forms an interesting record of an increasing water supply gained from the sinking and operation of a large number of deep wells to keep pace with the development of a city having a population of 25,000.

When primitive man abandoned the nomadic habit, which is still manifest in some Asiatic tribes and in the life of gypsies, he naturally settled down close to a water supply; and near to streams grew the earliest communities. As towns arose and covered a wider area immediate access to the stream became more difficult for the distant house-holders, and out of this condition grew the necessity for and the development of systems for delivering water through ditches. The drying up of the closest streams after long seasons of drought, the increase of population, and the constantly growing demands for more water for other than ordinary domestic uses produced conditions that, in time, brought about the splendid stone reservoirs, aqueducts, and surface-delivery systems that reached a wonderful condition even 2,000 years ago for the city of Rome, where many of the original constructions are still extant.

With the development of civilization and the growth of modern cities more and more water has been required for the industries, for fire protection, for irrigation, and for domestic purposes. And wherever there is a natural demand for anything, that thing becomes worth something and salable, and inventive and ingenious man arises with projects for furnishing a supply and reaping the financial reward. Thus it is that man and corporations and cities themselves have gone far afield in search of a water source for growing communities that promised to require much more than was immediately available.

In California, owing to its peculiar climatic conditions and the cessation of rain during practically the whole summer period from the first of April to the first of October, the conservation of water has become a paramount principle governing the growth of the state. At times it has been impossible to supply enough water to the inhabitants of some congested centres of population. During a protracted dry season following a period of comparatively light snows on the mountains many of the streams have almost entirely disappeared, but generally below the beds of some of them have percolated water at a great depth. In some places wells sunk deep enough to tap these subterranean supplies have found water with sufficient pressure to bring it bubbling up and overflowing above the surface of the earth. These are artesian wells.

Stockton, although situated on the San Joaquin, one of the two great rivers of the State, cannot use river water for household purposes because it is brackish from the backing up of the high tides of San Francisco bay. When Stockton became the centre of distribution for supplies to the great mines along the mother lode then the necessity arose for obtaining a large supply of water for domestic purposes and for

fire protection, because the future of the town was assured. Deep wells were sunk and an artesian flow was secured, and the expansion of this principle is the basis of Stockton's supply.

The history of the Stockton Water Company covers a period of half a century. In 1859, ten years after the first wild rush of goldseekers into California, P. E. Connor made a contract with the town of Stockton and the county of San Joaquin whereby for a period of twenty years he was to have the use of wells owned by the town on a certain lot, was to pay $10 a month rental for the lot with the privilege of purchase, and was to supply the town and county's needs of water for a consideration of $700 a year. This arrangement was the beginning of the water company that gave Stockton a supply that its citizens could obtain as regular customers of the company. But it was not until August of 1867 that the company was incorporated, and then its capital stock appeared as $100,000, and it had a franchise that would run fifty years. Evidently O'Connor bought the lot from the city, because the records show that a few days after the incorporation papers were filed he deeded the lot to the Stockton Water Works Company, which was practically owned by L. L. Bradbury and wife of Los Angeles. The Bradburys retained possession until 1891, when they sold everything but the lot to the present Stockton Water Company.

This Stockton Water Company was organized in October of 1890, with W. S. McMurtry of Los Gatos, W. S. McMurtry, Jr., of San Francisco, John Flournoy of San Francisco, C. T. Ryland of San Jose and R. D. Murphy of San Jose as its incorporators. A twenty-five-year franchise was obtained, and it will expire November 25, 1915. In 1895 the Blue Lakes Water Company secured a controlling interest in the stock, and in 1908 legal title to the system. In 1904 the property was absorbed by the California Gas and Electric Corporation, and in 1908 it was transferred to the title of the Pacific Gas and Electric Company.

In 1884, during the Bradbury ownership, pumping from the city lot was abandoned, because in 1882 and 1884 some lots had been bought east of Stockton, and deeper and better wells were sunk on them. The first of these deep wells flowed originally 10,000 gallons an hour and the second 5000 gallons an hour, and they continued thus to flow into a surface reservoir in lessening volume until 1889, when they ceased altogether. Since 1889 there has been no flowing water from any of the wells. Pumps have been necessary.

In 1891 the Stockton Water Company issued $350,000 in bonds, running twenty years and bearing 6 per cent interest, and with this capital started a system of cast iron mains. Shortly before this the city of Stockton had bonded itself and laid four miles of mains for fire protection purposes and with the intention of getting its own water supply. But the water company leased the city's new mains, and in consideration of the use of them agreed to supply free water for fire protection.

The company paid dividends from 1891 to 1898, and then, because the city council, voicing the hostility of the people, had cut down the rate schedule about 35 per cent, there was so little revenue that no dividends were possible, and for a time there was not sufficient for the payment of the interest on the bonds. But since that period of depression the rates, after strenuous efforts annually applied, have been raised slightly four different times until in 1909 by close economy and the help of the natural increase in business a fair earning capacity has been attained. But ever since 1898 all surplus earnings have been put back into improvements of the system.

When, in 1891, the Stockton Water Company took control there were approximately 800 consumers' accounts. In July of 1909 there were 4,181 individual accounts of consumers, 229 fire hydrants, 309 sewer flushers, and forty-five miles of street mains from twenty-inch down to four-inch diameter.

The daily output of water in July and August is now about 4,500,000 gallons, and in December and January, about 1,800,000 gallons. The average per capita consumption for the 25,000 population the year round is 109 gallons a day.

Because domestic water is easily obtainable in Stockton at a depth of seventy feet the company has had an uphill fight against the competition of private wells and windmills over a scattered community. An inadequate company service in earlier years created public resentment. But under the present corporate control and its adequate financial backing it has been possible to produce a first-class service and a capacity that has anticipated the future needs of the city. This good service, coupled with reasonable rates, has abated and removed the old antagonisms and made the company's service so popular that no new windmills have been constructed within the area of the company's system and the old ones are rapidly becoming disused.

The wells furnishing Stockton's supply of water, their depth, when they are bored, and the size of the casing are all shown in the accompanying table:

At Pumping Station No. 1.

Deep Well.	Bored.	Depth in feet.	Size of Piping in inches.
1st	1882	1,100	8 (below 800 ft., 7-in.)
2d	1884	960	6 (below 650 ft., 5-in.)
3d	1885	1,040	8
4th	1891	560	10
5th	1895	218	8
6th	1895	218	8
7th	1895	300	8
8th	1895	577	8
9th	1900	770	12
10th	1902	223	20
11th	1906	950	12
12th	1907	1,002	14 (below 268 ft., 12-in.)
13th	1908-9	1,050	14 (below 250 ft., 12-in.)

At Pumping Station No. 2.

1st	1903	667	12 (below 632 ft., 10-in.)
2d	1904	807	12 (below 594 ft., 10-in.)
3d	1909	960	14 (below 260 ft., 12-in.)
4th	1909	(boring)	14

Wireless telegraphy from airships by means of the new Telefunken singing spark system has proved satisfactory on some of the Zeppelin airships in Germany, which easily maintain communication with land stations for distances of over thirty miles.

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Changes of advertising copy should reach this office *ten days in advance of date of issue.* New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
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CONTENTS

Lighting Rates and Costs

The choice of a proper charge for electric lighting is a vital question to central stations. The commercial success of the high-efficiency lamp prematurely forced this issue, inevitable either from competition or governmental regulation. In some cases the service charges made by a new company have proved too low, while there are others correspondingly too high. It is now possible to so predetermine costs that rate-fixing is no longer a matter of guess-work or an arbitrary levy of all that the traffic will bear. It consequently behooves every power company to carefully analyze its costs so as to properly synthesize its rates.

One of the best proposals for such an analysis is contained in a paper read by S. E. Doane before the recent St. Louis convention of the National Electric Light Association. This paper is primarily concerned with the effect of high-efficiency lamps on central station costs. The author has segregated all cost items, such as general expense, generating and distributing expense, taxes, insurance, depreciation, interest and dividends, under the three heads of "output," "demand" and "consumers." The relative proportion of each of these cost items which is in any way affected by increasing the number of kilowatt-hours generated, without increasing the plant's capacity, is listed under "output"; the percentage charged to "demand" represents the cost dependent upon the station's capacity; the portion assigned to "consumers" is that part which is increased or decreased with change in the number of consumers connected. Taking an average for a large number of stations throughout the country, Mr. Doane allots 14.6 per cent to "consumers," 30.3 per cent to "output" and 55.1 per cent to "demand." As these figures are but averages and necessarily vary with each company studied, they may be easily remembered as a geometrical progression of approximately $1/7$, $2/7$ and $4/7$ respectively.

A local application is interesting. In the present rate war between the Edison company and the municipal plant at Pasadena, California, the officials of the latter are quoted as saying that current can be profitably sold at five cents per kilowatt-hour, provided the number of customers is increased from 2135 to 4000, the former rate being seven cents. Assume that the number of kilowatt-hours generated increases in the same ratio as the number of customers, $7/8$, and that no increase in station capacity is necessary. Then that proportion of the expense due to new consumers becomes $1/7 \times 7/8 = 1/8$ increase, that due to increased output is $2/7 \times 7/8 = 1/4$ increase, a total of $3/8$, there being no "demand" increase. The income from 4000 consumers at $5/7$ the former rate to 2135 consumers, assuming like consumption, is $1/3$ greater, $3/8 - 1/3$ thus showing a slight loss. This apparent loss is undoubtedly due to conditions at Pasadena which would reduce the cost factors we have employed merely to emphasize the general applicability of the method which is a good start in the right direction of basing rates on costs.

PERSONALS.

Francis E. Wilkinson of New York and London is visiting San Francisco as a guest of Leo D. Haas.

K. G. Dunn, engineer with Hunt, Mirk & Co., of San Francisco, left last week for an extensive Eastern trip.

R. Holterman of the Holahird-Reynolds Company has returned from Seattle, where his firm has a branch house.

P. M. Downing and S. J. Lisberger of the Pacific Gas & Electric Company have returned from a trip to Chicago.

C. Eccles, manager for Eccles & Smith, an electric railway company in Los Angeles, is a San Francisco visitor.

Frank Morse, manager of the Coquille River Electric Company of Coquille, Ore., was a recent arrival at San Francisco.

R. C. Gillis has been elected president of the Los Angeles-Pacific Company, Los Angeles, Cal., to succeed E. P. Clark, resigned.

F. H. Poss, manager of the San Francisco office of the Benjamin Electric Mfg. Co., left this week for a two months' trip east.

J. H. McDougal has joined the commercial department of the Pacific Gas & Electric Company under S. V. Walton at the main office.

R. S. Buck, an electrical engineer with Sanderson & Porter, has returned to New York after spending several months on the Pacific Coast.

J. J. Von Dohlen, fiscal agent of the Canadian Electric Water Heater Company, has arrived from Vancouver, B. C., on his way to New York.

Edward Whalley of the Northern California Power Company's main office has returned after visiting the company's power plants in Shasta County.

P. H. Coolidge, assistant general manager, and F. C. Phelps, auditor of the Pacific Telephone & Telegraph Company, recently visited Los Angeles.

A. E. Wieland, formerly of the Entiat Light & Power Company, and Walter Thomas have opened offices as irrigation engineers at Wenatchee, Wash.

V. W. Shear, engineer of the turho-generator department of the Westinghouse Electric & Mfg. Co., is making a tour of the company's Pacific Coast district offices.

W. W. Briggs, Pacific Coast district manager of the Westinghouse Electric Manufacturing Company, has returned from a trip to Pittsburg after an absence of several weeks.

N. A. Carle has opened an engineering office at No. 510 Central Building, Seattle, Wash., and is prepared to do consulting and constructing work in mechanical, electrical and mining engineering.

J. M. Yount has resigned as master mechanic of the Union Railway, New York, N. Y., to become master mechanic of the United Railroads, San Francisco, Cal., to succeed Mr. F. F. Bodler, resigned.

Lee De Forest arrived at San Francisco last week to install a De Forest wireless telegraph plant on the United States transport Buford. The radiotone sparkless type of apparatus is being installed.

Herman R. Erkes has resigned as purchasing agent for the Ventura County Power Company, Oxnard, Cal., to assume similar duties for Bailie & Brandt Co., machinery merchants and engineers of Los Angeles, Cal.

J. A. Murray, commercial manager of the Pacific Telephone & Telegraph Company's office at Roseburg, Ore., was recently transferred to Everett, Wash., as manager, being succeeded by W. C. Mumaw of Seattle.

Ely C. Hutchinson, commercial engineer for the Pelton Water Wheel Company, will leave next week for an extended tour of the Pacific Northwest in connection with pending contracts that are to be placed with his company.

E. G. Dewald, who was for several years Pacific Coast representative of the Platt Iron Works Company and more recently with the Allis-Chalmers Company, will, on July 1st, join the sales force of the Pelton Water Wheel Company.

H. M. Adams, general freight and passenger agent of the Spokane, Portland & Seattle Railway, Oregon electric railway and United Railways, at Portland, announces his resignation from those positions to accept the post of general freight agent of the Western Pacific road, with offices at San Francisco.

J. A. Vandergrift, manager of the Oakland Warehouse Company, left this week to attend the annual conference of the hranch managers of the National Electric Lamp Association, to be held at Association Island during the week of June 19th to 25th, and also to attend the summer meeting of the Licensed Association of Lamp Manufacturers, to be held at Association Island during the week of June 26th to July 2d.

H. H. Noble, president of the Northern California Power Company, has returned from Shasta county after witnessing the starting up of the Inskip power station on Battle Creek.

TRADE NOTES.

Hunt, Mirk & Co., representing the Westinghouse Machine Company on the Pacific Coast, have closed contracts with the Southside Light & Power Company of San Francisco for a Westinghouse-Parsons turbo-generator with a capacity of 1000 kw. and for the laying of conduits for a steam exhaust-heating system. The plant will be installed in a re-inforced concrete building to be erected on Minna street, adjoining the Rialto Building, on whose roof the cooling tower will be placed.

B. F. Kierulff, Jr. & Co. of Los Angeles, have been appointed representatives of the Mott Iron Works of New York City, manufacturers of ornamental light posts and fixtures, the Jefferson Union Co. of Lexington, Mass., manufacturers of pipe unions and joints, the Sprague Electric Company of New York, motor generators, and flexible steel armored steam and air hose and the Atlantic insulated Wire Company of New York.

Sanderson & Porter report the 100,000-volt power transmission of the Sierra & San Francisco Power Company from the Stanislaus river, has been started and that power is now being delivered in San Francisco to the United Railroads regularly. This power is being used at the Bryant avenue, Geneva avenue, and Millbrae sub-stations, being all 60 cycle current at 12,000 volts. The operation of the Bay Shore substation as well as the rest of the United Railroads sub-stations, is in charge of Mr. Bivins, superintendent of electrical equipment of the United Railroads. Although this is the latest transmission system to reach San Francisco it is the shortest, the length of pole line being 135 miles as against 148 miles for the nearest competitor.

MEETING OF THE NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION.

The tenth annual convention of the National Electrical Contractors' Association will be held in Atlantic City, New York, July 20, 21 and 22, 1910. An interesting program of papers and many attractive features of entertainment have been provided, as it is hoped to make it the largest and most interesting convention held by this organization

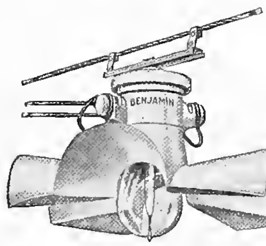
OBITUARY.

Frank E. Corwin died at his home in Oakland, California this week, the funeral being held on June 16th from his late residence. Mr. Corwin was recently compelled to give up the management of the Pacific Coast office of the Bryant Electric Company on account of his illness.

INDUSTRIAL

THE BENJAMIN PARABOLITE.

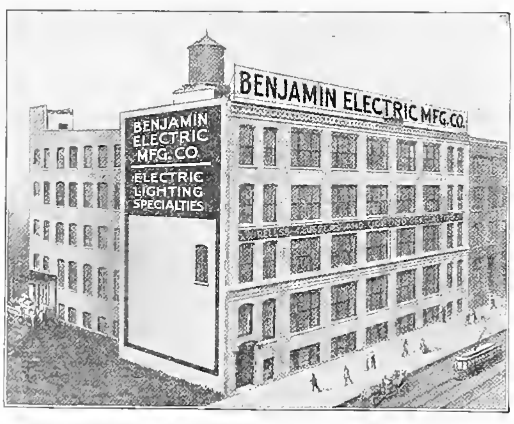
The Parabolite is a new fixture of the Benjamin Electric Manufacturing Company of Chicago, for street lighting with Series Mazda Lamps. By means of a porcelain enameled steel reflector composed of four intersecting semi-parabolas surrounding the lamp, the greater portion of light is projected down the center of the street, and only the necessary minimum amount is allowed to reach the street corners. As a result the light secured for the street proper is increased more than 50 per cent as compared with the usual amount when allowed to radiate over 360 degrees. Where it is desirable to suspend the fixture in the center of the block, reflector with two (2) instead of four (4) semi-parabolas is furnished.



Benjamin Parabolite.

The body of the device is composed of a porcelain base forming the main part of the socket, and integrally formed knobs. This base is supported by an iron fitting attached by four screws. The fitting in turn is covered by a porcelain petticoat insulator, which is held in position by a metal bushing screwed into the supporting casting.

The porcelain knobs are located as nearly as possible in line with the bottom of the metal supporting flange. The strain of the wires has therefore little or no leverage, and the danger of breaking the insulator is thus lessened. The binding plates are well protected, and are readily accessible.



New Chicago House of Benjamin Electric Mfg. Co.

The socket is provided with a spring center contact serving as short-circuiting device when the lamp is removed or accidentally loosened. It thus prevents the film from being punctured except when the lamp filament is broken. A heavy porcelain ring carrying the threaded socket shell and film cutout is connected with the main socket by means of a bayonet snap lock, and can only be removed by pulling the porcelain downward and turning it to the left. The strain of placing or removing the lamp cannot unlock connections.

WESTERN ELECTRIC NEW DESIGN SIGNALING SYSTEM FOR MINES.

The Western Electric Company announces that it is prepared to furnish a new design of emergency signaling apparatus for mines which complies fully with the laws of Illinois and other States regulating the use of telephones and emergency signaliug system in mines. The new signaling system cousists of a generator signaling set and the regulation emergency eight-inch signal bells or gongs. The generators used in the signaling sets are designed in two sizes to accommodate systems which require a large or small equipment of gongs.

The smaller of the two generator equipments consists of a five-bar magnet generator mounted in an iron case, as shown in Fig 1. In appearance this case is similar to that of the new mine telephone set which the Western Electric Company placed on the market a few months ago. This five-bar generator will operate the equivalent of twenty-eight-inch, loud-ringing extension bells over eight miles of full metallic

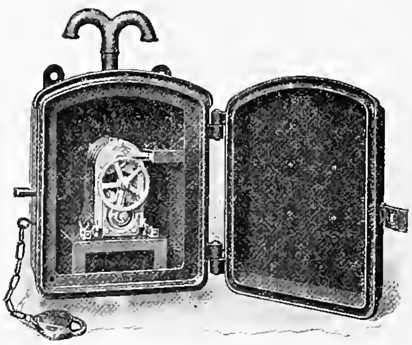


Fig. 1.

No. 12 B. W. G. iron wire. The magnets of the generator are of the highest grade magnet steel and are hardened and aged to insure retaining their strength indefinitely. The bearings are large and well proportioned and the crank furnished is of a design which enables the generator to be rung easily when fully loaded.

The larger signaling set consists of a fourteen-bar magnet generator mounted in a metal case similar to that of the five-bar magnet equipment and is similar to that equipment in every detail except size. This generator will ring the equivalent of sixty eight-inch gong emergency bells over an eight mile line.

In each of these types the generator is arranged in an iron box provided with a padlock, ordinarily to be kept locked. To protect the generator when the outer door of the box is opened, a steel cover is fastened over the opening of the box and in front of the generator. This cover removes the possibility of any part of the clothing of the party operating the generator being caught in the generator wheels and also protects the generator from interference by other foreign substances which might collect should it be exposed while the door is open.

A compartment in the front of the door of the box equipped with a glass front is provided for the key to the set. It is the intention that a key to the set shall always be kept in this compartment and that this key will be used only in cases of emergency, when anyone may break the glass front and obtain the key to open the set. This compartment is to be made air-tight so that it will be impossible for dust to get inside and hide the key from view. The back of this com-

partment is to be painted white so as to make the key more noticeable.

It is also intended that the foreman or man in charge of the mine shall be provided with an extra key to enable him to open the box nnder ordinary conditions in the mine when it is desirable to operate the generator for fire or emergency call drill.

The same precantion against water following the line wires into the case of the signaling set is taken as in the Western Electric new design of mine telephone. The curved inlet at the top provides an entrance which removes the possibility of water flowing along the line wires and into the set.

The emergency signal bell used with the generators con-

Signalling Apparatus for Mines.

sists of a non-sparking bell provided with two eight-inch steel gongs monnted upon a wooden or steel backboard and having a protesting canopy. The gongs are not galvanized and have an especially loud and clear tone. All parts, inclnding the windings, are specially treated to stand conditions of mining atmosphere.

The signal system above described may be used with or independent of a telephone system. For mine telephone service the Western Electric Company has new designs of metal and wood sets and also a new design of an inter-communicating metal mine set, all of which are fnlly up to the standard of the telephone apparatus furnished to the telephone companies in the "Bell" system, who are its principal cnstomers.

WESTINGHOUSE REPORT TO STOCKHOLDERS.

The annnal meeting of the stockholders of the Westinghouse Machine Company for the election of directors and for the transaction of such other business as may properly be brought before the meeting, will be held in the general office of the company in East Pittsburg, on Tuesday, June 21, 1910,

Messrs. Haskins & Sells, certified public accountants, have made an examination of the books and accounts and have certified to the balance sheet as of March 31, 1910, the close of the fiscal year, and to the earnings of the company during the eight years ending that date. The following is an extract from their report:

Average annual net income available for interest and dividends, or for capital acconnts for the eight years ended March 31, 1910 .... $720,543.78

Average annual net income available for interest and dividends, or for capital acconnts, for the five years ended March 31, 1910 .... 736,719.05

Average annual net income available for interests and dividends, or for capital accounts, for the period from April 1, 1903, to March 31, 1910, exclusive of the years ended March 31, 1908 and 1909 .... 841,119.86

The two fiscal years eliminated cover a period of general business depression and of the receivership and reorganization of the company.

New income available for interest and dividends, or for capital accounts, for the year ended March 31, 1910 .... 875,845.33

Net income available for interest and dividends, or for capital accounts, for the quarter ended March 31, 1910, $330,286.38, or at the rate per annum of $1,321,145.52

It is of interest to note that the orders received for shop product during the fiscal year just closed, ending March 31, 1910, aggregated $5,125,612.52, an increase of $2,322,536.88, or 83 per cent, as compared with $2,801,075.64 during the previous fiscal year; that the billing in shop product for the fiscal year amounted to $4,065,618.74, an increase of $1,309,-912.94, or 48 per cent, as compared with $2,755,705.80 during the previous year; and that the net addition to surplus after deducting depreciation and interest charges (excluding the amount written off for an investment in a subsidiary company manufacturing storage batteries which was liquidated during the year) is $429,566.61, as compared with a loss of $228,-123.54 during the previous year, a betterment over the previous year of $657,690.15.

NEW CATALOGUES.

The advantages of J-M Fibre Conduit are briefly detailed in an illustrated booklet from H. W. Johns-Manville Co.

Bnlletin No. 390 from the National Brake and Electric Company of Milwaukee, Wis., is devoted to National pneumatic motor governors for electric railways.

The Linton Machine Co., 26 Cortlandt Street, New York, have published an illustrated description of the Komo steam trap for the separation of the water of condensation from steam.

The Carb-Ox Company, Rogers Park, Chicago, Ill., have issued an interesting catalogue of portable instruments for gas analysis and gas sampling by the Hays method. This apparatns enables the power producer to work out the highest economies in the use of fuel, whether coal, oil, gas or refuse.

Bnlletin No. 4727 illustrates and describes two types of the General Electric Company's sewing machine motors which may be easily applied to any of the standard sewing machines of either drop head or stationary head types. These motors are intended for ordinary domestic use, and are made for alternating and direct current of standard voltages.

H. W. Johns-Manville Company have issued the first number of the J-M Roofing Salesman, which will be issued on the 28th of every month in behalf of J-M roofings and allied J-M building materials. This is a companion pnblication to The J-M Packing Expert, which is mailed on the 14th of every month to engineers and others interested in highest grade packings.

The General Electric Company has recently issned their Bulletin, No. 4737, illustrating and describing an Electric Hardening Furnace designed for the hardening or tempering of tool steel. In the operation of this furnace, metallic salts are brought to a liquid state by passing electric current through them, and the heating of the tool to be hardened can be exactly controlled and kept uniform throughout over a wide range of temperature.

Bulletin No. 4738, entitled "Belt Driven Revolving Armature Alternators," has been issued by the General Electric Company, and describes three sizes of polyphase, 60-cycle generators for use in small isolated plants. These generators are of the belt driven revolving armature type, and are designed for service at any power factor between .8 and 1.0. They range in capacity from 7½ to 25 kilowatts, and are furnished for 120, 240, 480 and 600 volts.

NEWS NOTES

INCORPORATIONS.

GREAT FALLS, MONT.—The Great Falls Power Company has been organized by C. F. Kelly of Butte et al. with a capital stock of $15,000,000.

ASOTIN, WASH.—The Grand Ronde Power Company has been incorporated for $1,000,000 and an authorized bond issue of $2,000,000. Power to the extent of 10,000 h.p. will be developed on the Grand Ronde.

LOS ANGELES, CAL.—The Sunland Rural Telephone Company has been incorporated by Philip Begue, C. B. Johnson, W. H. Mears, J. L. Hauber and W. B. Blumfield, all of Los Angeles, with a capital stock of $10,000.

TRANSMISSION.

PE ELL, WASH.—The Central Power Company has started work on its dam across the Columbia river at this place.

GRANGEVILLE, IDAHO.—The Big Bend Light & Power Company will increase the capacity of its plant and extend the service to Cottonwood.

EVERETT, WASH.—The Northwest Light & Power Company is planning to increase the capacity of the local plant from 60,000 to 1,000,000 feet of gas daily.

EUGENE, ORE.—Ball & Wilson received the contract for constructing the heating plant to be constructed for the Eugene Heating & Power Company, at $2100.

PEAVINE, NEV.—Surveyors are at work here, employed by the Loon Lake Water & Power Company, preparatory to erecting an hydroelectric power plant on the Rubicon river.

GOLD HILL, ORE.—B. H. Harris, president of the Gold Hill Railroad & Lumber Company, will either put in a power plant in Gold Hill on the Rogue river, or bring power from Butte Falls.

PORT TOWNSEND, WASH.—The Olympia Power & Transmission Company, a corporation capitalized at $1,000,000, with George A. Glines of Winnipeg and Thomas J. Aldwell as organizers, has completed plans for the building of a power line from the Elwah river to this city.

WALLA WALLA, WASH.—The Columbia Power & Light Company, of Portland is in the market for poles, cross-arms and pins for a 45-mile, 66,000-volt line from Walla Walla to Pasco, Washington. Construction will begin immediately, the County Commissioners having granted a fifty-year franchise. The Snake river will be crossed near Pasco by means of a 1600-foot span on steel towers.

TRANSPORTATION.

NORTH BEND, ORE.—The City Council has granted a franchise to the Coos Bay Rapid Transit Company for an electric line.

ALBANY, ORE.—It is reported that the construction of the Oregon Electric Line from Salem to this place will be started at once.

VICTORIA, B. C.—The British Columbia Electric Railway Company will extend its system on Vancouver Island through the Saanich peninsula.

PORTLAND, ORE.—The Mt. Hood Railway, Light & Power Company has secured right of way from Gresham to Portland. It is reported that active work will start this summer.

EUGENE, ORE.—Engineer F. B. Kidder of the Asset Company has gone to Coos Bay to start preliminary work on the proposed electric line from that place to Eugene.

VANCOUVER, WASH.—The Clark County Railway Company is planning the extension of an interurban line from here to the townsite of Sifton, a distance of five miles.

PALO ALTO, CAL.—F. E. Chapin, of the Peninsula Railway, formally announces that the construction of the line from Mayfield through the Stanford estate to San Mateo is to be started in the near future. He states that satisfactory arrangements have been concluded with the University authorities for the right of way on the Stanford estate.

SEATTLE, WASH.—The Bainbridge Development Company, M. B. Jackson, Jr., president, Bailey building, has secured a franchise from the commissioners of Kitsap county for the construction of electric railway lines from Eagle Harbor to Port Madison, Eagle Harbor to Manzanito and Eagle Harbor to Port Blakeley and Pleasant Beach, a total of 28 miles, to be operated in connection with a ferry service to Seattle.

BERKELEY, CAL.—Surveyors for the Oakland Traction Company are laying out the profile of the proposed Euclid avenue car-line extension from University and Shattuck avenues, to the end of Euclid avenue in the Wheeler tract. The franchise, as applied for, will be granted June 19, and the work of construction will commence immediately after. Owing to the heavy grades from Hilgard street north, low geared cars with high-powered motors will be necessary.

SAN FRANCISCO, CAL.—Seventy thousand dollars has been invested in a suburban railroad 70 miles in length which is to be built from Niles and to connect with Redwood City across the bay, taking in Dumbarton Point on the way. The project took legal shape when articles of incorporation were filed under the name of the San Francisco and Transbay Railroad Company. A million and a half of capital is authorized, though the stock actually subscribed, amounts to but $70,000. Of this $60,600 stands in the name of Attorney H. H. McClosky. The other incorporators, nominally are: E. Schnulenhaus, J. Comerford, A. Mulverhill and L. Block. Besides the main line from Niles to Dumbarton Point and crossing the bay with connections to Redwood and Woodside through San Francisco, a branch is to run from Redwood to Woodside, and from Dumbarton to Warm Springs.

OAKLAND, CAL.—The wharves and waterfront committee of the City Council has recommended the passage of an ordinance to grant to the San Francisco, Oakland and San Jose Railway a franchise for 1000 feet of wharfage space on the western waterfront. The strip includes the existing Key Route pier, for which no franchise was ever granted. Several amendments of utmost importance were written into the ordinance. The chief one was suggested by President Pendleton of the Council. It provides that the city may, with the consent of the War Department, extend the bulkhead line 2000 feet west of the low-tide line of 1852. This will give the city 206 acres to be filled with solid earth, thus creating waterfront land which Pendleton maintains would immediately be worth $12,500 an acre. The ordinance, if passed, will guarantee to the company fairways of 1000 feet on each side of its proposed grant. The company agrees to deed back to the city all wharfing-out rights it claims in the Key Route basin; to dedicate extensions of Seventh, Fourteenth and Twenty-second streets, through its tide lands to the low tide line, and to pay the city a rental of $75,000 during the 50 years' term of the franchise.

ILLUMINATION.

OLYMPIA, WASH.—The City Council has granted a new 40-year franchise to the Olympia Gas Company.

SAYULA, MEX.—This place will soon have an electric lighting plant, operated by a gas producing apparatus and engine.

GOLDFIELD, NEV.—The Hydro-Electric Company of Bodie is preparing to construct a power line into Rawhide to supply that camp with power and light.

WILLOWS, CAL.—The Northern Electric Power Company has given official information that it will soon construct a gas works in Willows to supply gas for light and heating.

MESA, ARIZ.—The contract for the erecting of a plant for the South Side Gas Company, on the property north of the N. & P. station, was let to L. E. C. Smith. The building will be 40x80 feet.

MARSHFIELD, ORE.— R. M. Jennings, the general manager and treasurer of the Coos Bay Gas & Electric Company, has announced that the company will make improvements to its gas plant to cost $200,000.

LOS ANGELES, CAL.—During the summer an electric lighting system extending from the Sunset Boulevard to the Bungalow Land in Laurel Canyon will be installed by the owners of the Lookout Mountain Bungalow Land and C. F. Harper.

EUGENE, ORE.—The Byllesby Company, owners of the Eugene Electric Light & Gas plants, has announced that it will spend $230,000, in improvements in and about Eugene. tI will rebuild the Eugene gas works and several miles of mains throughout the city.

OLYMPIA, WASH.—O. K. Thompson has filed on a water right in Yelm creek for the purpose of operating an electrical power plant. The site is about three miles northeast of Yelm and near the town of McKenna so that either town can be supplied with light and power.

SAN DIEGO, CAL.—The electric lighting system at Fort Rosencranz which is located near San Diego, California, has been connected with the transmission lines of the San Diego Consolidated Gas & Electric Company for service. The connected load is equal to about 1400 16 candlepower equivalents.

LOS ANGELES, CAL.—Board of Supervisors passed an ordinance granting G. S. Forney a franchise to operate a system of gas pipes in the following district: All public roads and highways in township 1 north, range 10 w.; township 1 north, range 11 west, and township 1 south, range 10 west and township 1 south, range 11 west, S. B. B. and M.

GRANGEVILLE, IDAHO.—The Big Bend Electric Light & Power Company, which recently purchased the plant of the Grangeville Light & Power Company, has taken possession. Eugene Enloo of Spokane is the manager, and announces that his company will spend, within the next three months, about $50,000, enlarging and improving the plant and extending the service lines to Cottonwood.

SAN FRANCISCO, CAL.—City Attorney Long has advised the Supervisors that the city has the legal power to erect an electric light plant in Golden Gate Park to light the park and that such power must be exercised by the Park Commissioners in the absence of an ordinance granting such power to the Board of Works. He holds that the plant cannot be used for the purpose of furnishing light to the surrounding districts.

RED BLUFF, CAL.—The transfers of 12 United States patents for land from the Southern Pacific to H. A. Kluegel, and by him to J. W. Goodwin here gives reason for the opinion that another power company will exploit Tehama county. The deeds transfers 680 acres of land on Mill Creek, 20 miles southeast of this city. Goodwin is president and a heavy stockholder in the Oro Water, Light & Power Company, which has a power plant in Butte county, north of Oroville, and contemplates the construction of a plant at Humbug Valley, in Plumas county.

LOS ANGELES, CAL.—When the application for a receiver for the San Bernardino Valley Gas Company came before Judge Wellborn it was found that a petition had been filed by 80 per cent of the creditors, including holders of loans and securities, asking that a receiver be not appointed. It is declared that the company has an income of $20,000 a month and is solvent. A few days ago a conference of the largest creditors and the officials of the company was held, and it was unanimously agreed that the best interests of all demanded that the petition for a receiver be opposed and defeated if possible. The business is claimed to be on a paying basis.

SALT LAKE CITY, UTAH.—Announcement is officially made by President William H. Bancroft that contracts have been let to Westinghouse, Church, Kerr & Co. of New York for the 11,000 h.p. reserve station for the Utah Light & Railway Company. It will be located on the Jordan river, near the company's present transformer station and steam plant, and work is already under way on the preliminaries. The cost will be between $600,000 and $750,000. The plant will be installed for the purpose of providing an absolutely continuous supply of electricity for lighting, power and street railway operations in Salt Lake and Ogden.

SAN BERNARDINO, CAL.—The bankruptcy proceedings which were two weeks ago commenced against the San Bernardino Valley Gas Company, will probably be called off by the court because of the strong showing that was made in the answer to the complaint. The law provides that bankruptcy proceedings may at any time be defeated by an intervenor signed by a certain percentage of creditors and the strong showing made in this line it is thought will weigh heavily with the court in arriving at a decision. The bankruptcy proceedings were brought by Redlands interests which have not seemed to be satisfied with the status of the business, the action being brought against the advice of bankers in all the cities of the valley who felt that the business would be in far better shape if allowed to work its own way out.

SAN FRANCISCO, CAL.—The San Francisco Gas & Electric Company let a contract this week to R. D. Wood & Co., of Philadelphia, for a 5,000,000 cubic foot gas holder having a diameter of 195 feet and a height of 188 feet. The steel work will all be rolled punched in Philadelphia, and shipments by railroad will commence immediately, as there will be 2635 tons of steel for transportation. Meanwhile the company will put a large force of men at work preparing the foundations for this tank. The actual work of erecting the steel structure will begin August 15, with 350 men handling the steel sheets. The construction work upon the holder will keep this force at work for months but the engineers expect to have the holder completed and ready to receive gas by April 10, 1911. The holder will be built in the Potrero adjoining the present gas works.

PORTLAND, ORE.—The Portland Gas & Coke Company has elected the following new board of directors: C. F. Adams, chairman; H. L. Corbett, Guy W. Talbot, T. Scott Brooke, W. W. Cotton, R. L. Sabin of Portland; S. Z. Mitchell, F. G. Sykes and E. W. Hill of New York. The officers of the company are Guy W. Talbot, president; Geo. F. Nevins, secretary and treasurer; M. H. Arning of New York, assistant secretary and treasurer, and H. M. Papst, general manager. The Northwest Gas Equipment Company has disposed of its retail holdings in Portland to the Portland Gas & Coke Company, which has not been in the appliance business for some

PROFESSIONAL DIRECTORY

years. The Portland Gas & Coke Company will handle the retail field again, and the Northwest Gas Equipment Company will do a Pacific Coast wholesale trade only, with headquarters at 506 Lewis Building, Portland. W. M. Kapus is president and manager and Lewis A. McArthur secretary and treasurer.

LOS ANGELES, CAL.—The Los Angeles Gas and Electric Company has brought suit against the city of Los Angeles in the Superior Court to recover $23,884.80, paid as taxes on the franchise and personal property of the corporation. The assessment made by the county assessor last year on the property was as follows: Gas pipes, meters and distributing system, $234,000; electric regulators, $1,120,000; electric overhead distribution system (annex 1896) $84,000; electric overhead system (annex 1899) $11,000; electric underground system, $105,000; gas works plant, $890,000; electric works plant, $410,000; franchise to use the public highways of the city of Los Angeles for the introduction into and supplying the city and its inhabitants gas light and other illuminating light, $906,100. The prayer of the petition is that the assessment and tax upon the property of the plaintiff be set aside in toto, and if not in toto, as to any amount in excess of the valuation of $200,000, and a tax of $3234.

KLAMATH FALLS, ORE.—C. S. and R. S. Moore, capitalists of this city, have purchased the interests of Alex Martin Sr., H. V. Gates and E. R. Reames in the Klamath Light & Power Company and have secured control of all the available power rights on Link river, the stream that drains Upper Klamath Lake. The Moore Bros. already owned a valuable power plant on the west side of the river, and with the one which they have just purchased and which supplied the city of Klamath Falls with light and electric power they now have a monopoly of that line of business. The plant which the Moores own on the west bank of the river supplies electricity for Bonanza, Midland and Merrill. The plant which they just purchased and which suppplied the city of Klamath Falls was inadequate to the requirements made upon it, especially in the winter months and after the mills have begun to grind wheat. By combining the two plants it will he possible to utilize the surplus power which has heretofore been useless, and at the same time provide the city with a better service.

TELEPHONE AND TELEGRAPH.

ELY, NEV.—The White Pine Telephone Company contemplates expending $15,000 in improving its service in the district.

RED BLUFF, CAL.—Joe Tait has been granted a franchise to establish and maintain a telephone system in the town of Red Bluff.

DUNSMUIR, CAL.—The Southern Pacific is installing telephones in several stations between this point and Red Bluff with a view of operating trains by telephone. For some time the trains between Dunsmuir and Ashland have been operated by telephone. The sending of train orders on this division has proved very successful and the same system on several Eastern roads has been successful beyond all anticipations. The telephone system on railroads does not do away with the telegraph but supplements it.

WATERWORKS.

OAKLAND, CAL.—More than $5,000,000 will be spent by the Bay Cities Water Company in installing distributing systems in Oakland, Berkeley, Alameda and Piedmont, according to Engineer C. L. Gilman, who states that the plans of the water company were so far completed that work could be commenced on the distributing systems within 48 hours after orders had been received by section chiefs. Gilman declared that by the addition of large cross mains to the regular main system, and fire protection of the best kind could be given for an increase of 50 per cent in population, and which would be ample for the supply of the East Bay cities for many years to come. His figures for the distributing systems for the four East Bay cities follow: Oakland, $4,250,000; Berkeley, $650,000; Piedmont, $200,000 and Alameda, $450,000. This figure for the Alameda system is for the company's plan of distribution. The $830,000 called for by Water Expert Bannister in his estimate is for an elaborate system of cross mains. In 18 months from the day the first spade full of earth is thrown to the surface, Gilman says the Bay Cities Water Company will have its Mount Hamilton supply in Oakland, Berkeley, Piedmont and Alameda.

SAN FRANCISCO, CAL.—The shipping interests of San Francisco are protesting against the water charges at this port. It is declared that the Spring Valley Company, through excessive rates, imposes an annual unnecessary tax of more than $100,000 on the shipping of the harbor. The result naturally is to drive the sea carrying trade from San Francisco. The benefits of public docks are nullified. Water that may be purchased for 16c the 1000 gallons in East street costs $1.50 at ship's side a few feet distant. It is to remedy this state of affairs that the ship owners have protested to the Supervisors. Although its established harbor rate is $1.50 per 1000 gallons, Spring Valley sells its water to shipping companies with less regard to value than to what it can get. While many companies pay the full rate some concerns pay $1.25 per 1000 gallons, others 75c and the Southern Pacific only 16c. The condition has become so grave that the Pacific Coast Steamship Company announces that it will go into the water business on its own account and effect a big saving unless the price is cut. Even as it is, the shipping men are willing to pay as high as 32c per 1000 gallons. The Harbor Commissioners have for some time had the matter under consideration. President Walter V. Stafford has collected data which demonstrates the difficulties under which local ship owners labor. He has just been informed that the rate at San Pedro, a rival port, has been cut to 25c.

NEW CATALOGUES.

In Bulletin No. 4741, recently issued by the General Electric Company, Luminous Arc Lamps for Multiple Circuits are illustrated and described.

High Vacuum Surface Condensers for Steam Turbines are illustrated and described in Bulletin 106 from the Wheeler Condenser and Engineering Company of Carteret, N. J.

"Curtis Turbine Installations" is the title of an attractive publication recently issued by the General Electric Company and containing fifty illustrations of installations of Curtis steam turbine-generators of various capacities. The number of this publication is 4732.

In Bulletin No. 4736, entitled "Lightning Arresters," recently issued by the General Electric Company, are described various types of arresters for alternating and direct current, high and low voltage circuits. These arresters are described and illustrated in considerable detail.

Bulletin No. 4742, entitled "Electric Drive in Grain Elevators and Flour Mills," recently issued by the General Electric Company, describes in considerable detail the application of the induction motor to this work, and contains illustrations of a number of installations in various grain elevators and flour mills.

Line Drop Compensators for Circuits are illustrated and described in Bulletin No. 4740, issued by the General Electric Company. This compensator can be applied to switchboards already installed without any radical changes in the existing panels and can be mounted at any convenient place behind the panel or on the wall, the small leads only being brought to the instrument on the panel.

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POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

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JOURNAL OF ELECTRICITY
POWER AND GAS

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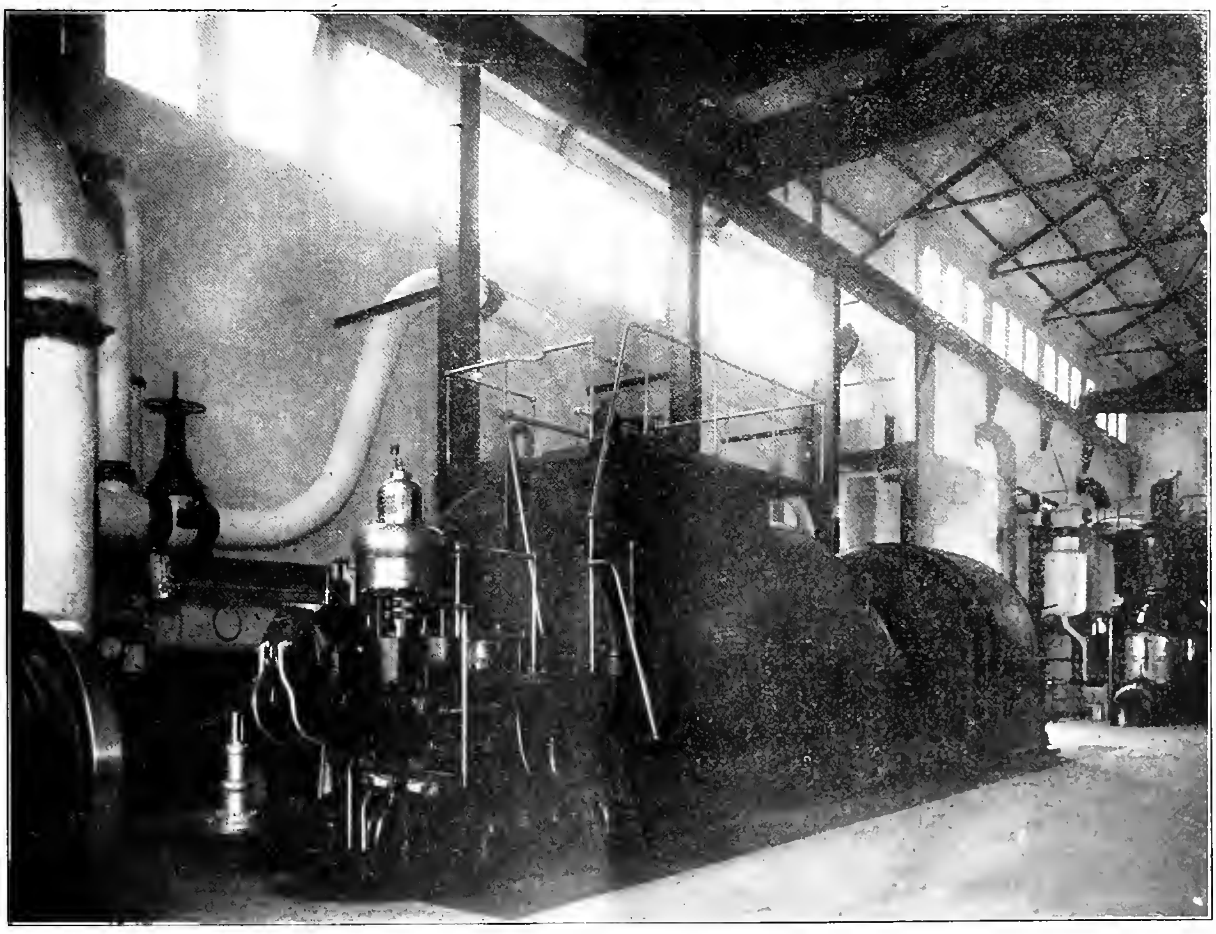
VOLUME XXIV SAN FRANCISCO, JUNE 25, 1910. NUMBER 26

POSSIBLE IMPROVEMENT IN STEAM PLANT ECONOMY[1]

BY L. R. JORGENSEN.



10,000 kw. Westinghouse Parsons Turbine at Southern California Edison Plant at Los Angeles.

Economy is the keynote of present-day engineering. Of two power stations, the one which produces a kw.-hour the cheaper under like conditions, will generally be considered to be designed the better. In the development of the steam power plant during the last century, its efficiency has been raised from about 1 per cent to a little over 10 per cent; especially in the last fifty years has the development been rapid and steady. In this period our old earth has seen more progress in all technical branches than it saw in 6000 or more years preceding, due mainly to the fact that engineering has been based upon scientific principles.

An efficiency of 10 per cent seems rather low and still it is above the average. Shall the next ten years see this efficiency increased to 20 per cent? To analyze how this efficiency can be improved, it is necessary to

[1]Paper read before San Francisco Section A. I. E. E., June 24, 1910.

follow the different transformations in detail, the first being the combustion.

I. Boiler Room.

This is the chemical combination of the combustibles with oxygen, of which the conversion of the carbon into carbon dioxide is of the most importance, mainly because it constitutes by far the largest percentage of the fuel, and also because the analysis of this part of the transformation can be made visible at all times, thereby enabling the boiler attendant to follow what his coal pile is going through, and to get the maximum heat out of it.

The fuel may be of any kind and grade. We will consider only the most economical air supply, and are, therefore, mainly interested in the percentage of carbon in the fuel. Anthracite coal contains from 92.5 to 97 per cent carbon, oil an average of 84 per cent. The heating value per lb. of anthracite coal is from 14,500 to 14,800 B.t.u.; per lb. of oil it is an average of 18,000 B.t.u., and per lb. of carbon 14,500 B.t.u., the same as some grades of anthracite coal.

To transform 1 lb. of carbon to carbon dioxide ($C + 2O$) it is necessary to supply oxygen in proportion to the combining weights of the two substances. As the combining weight of carbon is 12, and that of oxygen 16, we must supply $\frac{2 \times 16}{12}$, or 2.67 lb. of O for each lb. of C. We use the atmospheric air, and as this contains 23 per cent of oxygen (77 per cent nitrogen), we must supply $2.67 \times \frac{100}{23} = 11.6$ lb. of air for the complete combustion of 1 lb. of carbon. The weight of this gas will be $11.6 + 1 = 12.6$ lb., of which $2.67 + 1 = 3.67$ lb. are carbon dioxide, or $\frac{3.67}{12.6} = 29.1$ per cent by weight.

As no instrument is on the market, which will indicate certain kinds of flue-gases in per cent of weight, we must reduce this to volume. The specific volume of carbon dioxide is 0.0909; of oxygen 0.125, and of nitrogen 0.143. We have then actual volume of oxygen $2.67 \times 0.125 = 0.334$; of nitrogen $(11.6 - 2.67)\ 0.143 = 1.2770$; of carbon dioxide 3.67×0.0909, and percentage of CO_2 by volume $\frac{0.333}{0.334 + 1.277} = 20.7$ per cent.

This is the maximum percentage of CO_2 the flue gases can possibly contain. We have considered pure carbon only. For coal, with 97 per cent carbon, the percentage of carbon dioxide would be about 20, and would decrease as the percentage of carbon in the fuel decreased, but for comparison it is sufficient to use carbon. As we never have complete combustion in an ordinary boiler, the percentage of CO_2 will always be less than 20.7. By means of a CO_2 indicator, it is possible to follow the chemical transformation of the fuel at all stages, and keep the efficiency of this transformation at a maximum for the kind and grade of fuel used.

Heretofore, the fireman had to go by his "feeling" entirely in operating the damper; now with a CO_2 indicator installed he has at all times a visible record of what he is doing; he changes his damper opening until the CO_2 instrument shows maximum percentage of carbon dioxide. It has been found that the damper must be operated more often, and but little at a time, in order to give maximum average percentage of carbon dioxide, or, in other words, to give maximum evaporation per lb. of fuel.

In order to show what would be the approximate increase in boiler efficiency by the introduction of a carbon dioxide indicator, it is only necessary to find the efficiency of combustion for different amounts of air supply and compare them.

If 1 lb. of carbon, or a certain kind of coal, is burned, 14,500 B.t.u. are liberated; with 11.6 lb. of air, just sufficient for complete combustion, the furnace temperature will be $\frac{14{,}500}{(11.6 + 1)\ 0.27} = 4260$ degrees F.

The specific heat of air varies with the temperature. At 32 degrees it is close to 0.24; at 266 degrees it is 2 per cent higher, and at 446 degrees it is 5.68 per cent higher than at 32 degrees, but the percentage of increase for such temperatures as exist in the boiler furnace is not known. Enough has been done, however, to show that at such temperatures the specific heat closely approximates to 0.3. Therefore, the average specific heat will be taken 0.27.

In almost all calculations of this kind the writer has observed the factor 0.2438 (or 0.2375) has been used for the specific heat of air; it seems more correct to use the average specific heat, as the entering air must be heated from around 32 degrees to the maximum furnace temperature. For 150 per cent air supply, we will have a furnace temperature $\frac{14{,}500}{(17.4 + 1)\ 0.27} = 2930$ degrees. For 200 per cent air supply we will have a furnace temperature of $\frac{14{,}500}{(23.2 + 1)\ 0.27} = 2218$ degrees. For 300 per cent air supply, we will have a furnace temperature of $\frac{14{,}500}{(34.8 + 1)\ 0.27} = 1500$ degrees.

To 100 per cent air supply corresponds 20.7 per cent carbon dioxide.

To 150 per cent air supply corresponds $\frac{20.7}{1.5} =$ 13.8 per cent carbon dioxide.

To 200 per cent air supply corresponds $\frac{20.7}{2} =$ 10.35 per cent carbon dioxide.

To 250 per cent air supply corresponds $\frac{20.7}{2.5}$ = 8.3 per cent carbon dioxide.

To 300 per cent air supply corresponds $\frac{20.7}{3}$ = 6.9 per cent carbon dioxide.

In practical operation boilers are often supplied with as much as 300 per cent of air, whereas they can be operated with 150 per cent if a CO_2 indicator is used. The reason is obvious. In the former case, the fireman is dependent upon his instinct; in the latter, upon what he sees with his own eyes, which is a better basis from which to work. This is clearly shown in Mr. Stott's paper on "Power Plant Economies," Curve 3 and 4, page 6, in the Transactions of the A. I. E. E. for 1906. The difference in efficiency in the above cases would be as follows:

For every lb. of air discharged at a temperature say 400 degrees abs. atmosphere, there is wasted $400 + 0.27 = 108$ B.t.u., taking again the average specific heat of air 0.27.

In case No. 1 with 150 per cent air supply. 17.4 lb. of air to 1 lb. of carbon, the waste is: $(17.4 + 1)\ 108 = 1985$ B.t.u., efficiency $\frac{14{,}500 - 1985}{14{,}500} = 0.864$.

In case No. 2, 300 per cent air supply, 34.8 lb. of air to 1 lb. carbon. $(34.8 + 1)\ 108 = 3860$ B.t.u.; efficiency $\frac{14{,}500 - 3860}{14{,}500} = 0.735$. Or a difference of 12.9 per cent, which saving was brought about by the use of a CO_2 indicator.

On boilers using oil the saving would probably not be as great, as they can be fired with less average excess of air due to the fact that the conditions of combustion are more constant; the damper does not need to be operated so often. For low grades of coal the saving would be greater.

Comparing this gain in efficiency with the gain resulting from installing an economizer, we find this latter raises the efficiency less, and at the same time its first cost is from 10 to 20 times higher than the former. Still it is considered good practice to install economizers where the load factor is above 25 per cent and where coal is above $2.50 per ton.

Taking 2218 degrees as the furnace temperature (200 per cent air supply), 500 degrees as the temperature of the gases as they strike the economizer, and this to lower the temperature 100 degrees, we have the percentage of the total heat absorbed by the economizer:

$\frac{100}{2218 - 500} = 5.84$ per cent. For higher per cent of air supply, this would increase; for lower per cent it would be less.

In cutting down the air supply from 300 to 150 per cent (that is from 200 per cent excess to 50 per cent excess) the boiler efficiency has not only been raised 12.9 per cent, but the size of the smokestack has been cut in half, an additional important gain, for the simple reason that only half volumes of flue gases have to be handled. If the air supply is insufficient, or the mixture of air and flue gases incomplete, each atom of carbon will not be able to find two atoms of oxygen, but will combine with one atom of O only, forming carbon monoxide, and for each lb. of carbon burned this way there will only be liberated 4400 B.t.u., or $\frac{4400}{14{,}500} = 30.3$ per cent of the total heat. This would seldom occur in regular operation, although some percentage of the gases may be CO instead of CO_2, and this the indicator would not show; therefore, the actual air supply cannot be accurately calculated from the instrument readings.

II. Prime Movers.

If indicator cards taken from the three cylinders of any first-class triple expansion engine are replotted to the temperature entropy scale, it is plainly seen that the cards taken from the two first cylinders cover nearly 80 per cent of the ideal area, the third, or low pressure cylinder diagram, however, covers 45 per cent only.

As the economy of a first-class triple expansion engine is practically the same as the economy of a first-class turbine, it is at once evident that the high pressure cylinders (high and medium) can transform the heat in the steam into work more efficiently than a steam turbine; and with low pressure the turbine is so much ahead of the last engine cylinder that they finally come out even, or the turbine slightly ahead.

This fact is demonstrated in several power plants, where high pressure steam engines exhaust into turbines, and they then work on that portion of the cycle where they have their greatest efficiency. To see clearly why this is so, we will follow the action of the steam in the two cases.

Suppose we calculate a 500-kw. turbine, assuming that it will use 15 lb. dry saturated steam per h.p.-hour at 150 lb. gauge pressure, gives a steam consumption per hour of $670 \times 15 = 10{,}000$ lb.

We consider an impulse turbine first and choose 10 nozzles in two groups of five each, located diametrically opposite.

This will give $\frac{10{,}000}{10} = 1000$ lb. of steam per nozzle per hour. $\frac{1000}{3600} = 0.278$ lb. per second per nozzle.

Velocity of steam flowing into a space of less pressure is practically constant as long as this lower pressure is 58 per cent or less of the initial. This accounts for the fact that turbines do not lose so great a proportion in efficiency by changes in back pressures. The pressures in the different stages change with the load, but not enough to appreciably change the velocity of flow.

From steam tables we find the velocity of flow to

be 1481 ft. per second, initial pressure being 165 lb. abs., final pressure $165 \times \frac{58}{100} = 96$ lb. abs. with 2.5 per cent moisture in the steam at that pressure. Volume of 1 lb. of steam at 96 lb. abs. = 4.53 cu. ft., then area of throat of nozzle $= \frac{4.53 \times 0.975 \times 0.278 \times 12^2}{1481} =$ 0.119 sq. in. If the turbine must be able to carry 50 per cent overload, the area must be $0.119 \times 1.5 = 0.178$ sq. in., or 0.47 in. dia.

We want to design a turbine with four stages, and portion to be a smooth curve. This will allow the steam to enter upon the bucket without impact and leave it without commotion.

The velocity given up into work in this wheel is $1780 - 1500 = 280$ ft.; as no expansion has taken place the volume of steam is the same, but, as the velocity at the exit is 280 ft. less than at the entrance, the outlet area must be increased in proportion $\frac{1780}{1500}$, that is, the bucket length must be increased this amount.

The absolute velocity of the steam jet entering stationary buckets No. 1 is taken the same as the relative entrance velocity to moving buckets No. 1 = 1500

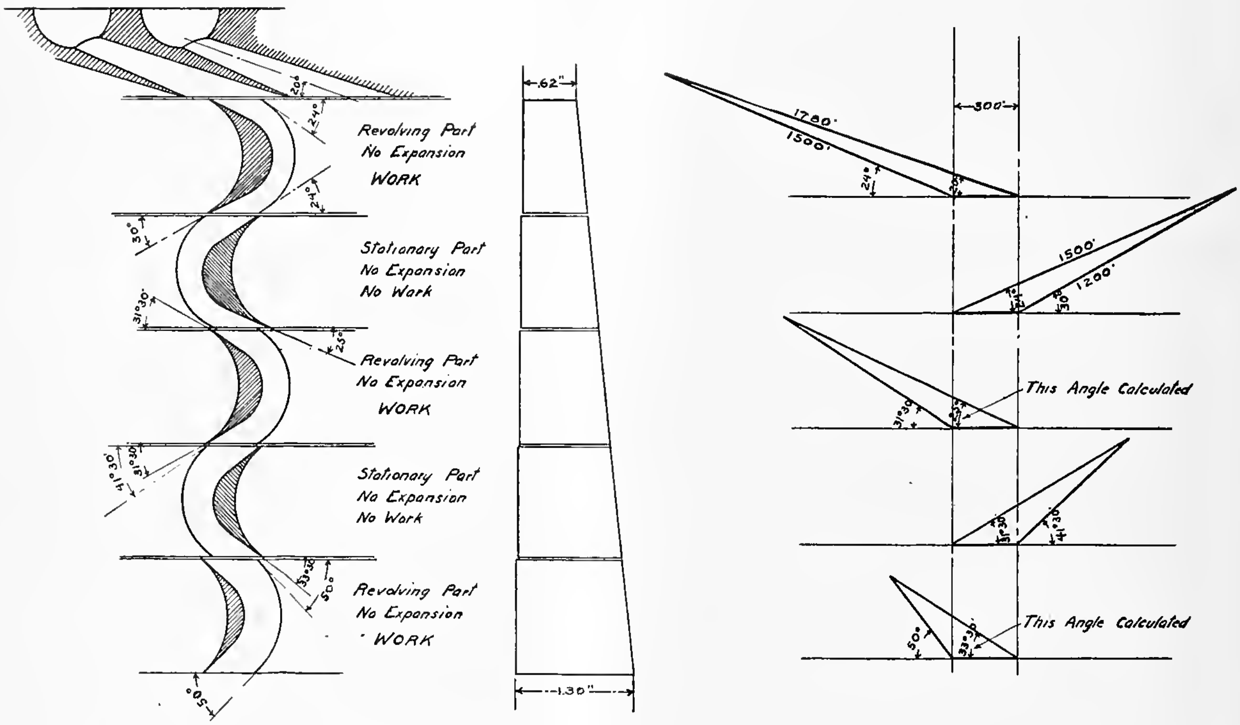


Fig. 1.

the pressure in the first stage to be 75 lb. abs. If saturated steam at 150 lb. gauge expands adiabatically to 75 lb. abs., we will have 95 per cent dry steam left. Volume of 1 lb. of steam at 75 lb. abs. is 5.71 cu. ft.; velocity of steam expanding from 150 lb. gauge to 75 lb. abs. = 1780 ft. Area of orifice =

$$\frac{5.71 \times 0.95 \times 0.278 \times 12^2}{1780} = 0.122 \text{ sq. in.};$$

for 50 per cent overload this area must be $0.122 \times 1.5 = 0.183$ sq. in. (cross section is made rectangular).

The different bucket angles are now found by means of a velocity diagram drawn to scale. The nozzles are made to include angles of 20 degrees with the wheel plane and the circumferential velocity of the wheel taken at 300 ft. per second.

The relative entrance velocity measures 1500 ft. and includes an angle of 24 degrees with the wheel plane; this is to be the angle of the first and last bucket element in the first row of buckets, the intermediate

ft. per second, which is only correct if we had no friction losses. However, if we use superheated steam, this will compensate for the friction losses, as we will start with a slightly higher velocity than the 1780 ft. per second.

Relative entrance velocity to stationary buckets No. 1 is found to be 1200 ft. and the angle it includes with the wheel plane to be 30 degrees; this will be the angle of the first bucket element.

No velocity is lost in going through this row of buckets, still the length of the buckets has to be increased in the same proportion as above to afford a smooth passage for the steam, and while the area must remain the same, the distance between blades at the exit must be smaller than at the entrance; this is also of advantage, as it affords an opportunity to decrease the angle between the last bucket element and the wheel plane. In this case the angle is calculated to be 25 degrees.

The absolute velocity of the steam entering the second row of moving buckets will, therefore, form an

angle of 25 degrees with the wheel plane, and the same calculation is repeated for the rest of the bucket rows.

It is seen that the bucket angles are getting larger as we go down and less work is taken up by each set of wheels, so we soon find a limit, where it does not pay to put on more rows.

The other three stages are calculated in the same way. Generally it is of advantage to take up more than one-fourth of the total work in the first stage, the steam volumes are smaller and the pressure in the turbine casing can be kept lower.

In the reaction turbine we have expansion taking place in both stationary and moving buckets. The main difference between the flow diagram for this kind of turbine and that shown in Fig. 1 is that the relative velocity is greater than the absolute velocity in the former case, and vice versa in the latter. The average velocity can thereby be kept smaller, thus reducing the friction loss, but the loss through leakage is evidently greater on account of the difference in pressure between all wheels, putting the two types on an equal basis as far as economy is concerned.

One lb. steam at 165 lb. abs. has a volume of 2.72 cu. ft. One lb. steam at 28 in. vacuum has a volume of 349.7 cu. ft. Saturated steam expanding adiabatically between 165 lb. absolute and 28 in. vacuum contain about 78 per cent dry steam at the end; the total expansion ratio would, therefore, be $\frac{349.7 \times 0.78}{2.72} = 100$. If the steam expanded from 165 lb. absolute to 29 in. vacuum, the expansion ratio would be about 200.

The above turbine is to make 1500 r.p.m. and will have a diameter of $\frac{300}{1500/60} = 3$ ft. 10 in. The ten nozzles of the first stage would cover about 15 per cent of the circumference, and as the steam expanded in the different stages, more nozzles would be put on, their cross sectional area increased and the bucket lengths made to correspond herewith to take care of the increased steam volume.

The last stage would have nozzles all around the circumference and would have buckets as long as practical; this is really the condition which determines the diameter of the turbine.

If a steam engine should take care of this expansion, 100 to 200 times the original volume, it would have impractically large dimensions for the last cylinder. As now designed, the steam can only be expanded to say 24 in. vacuum, and there is not much need for condensers, which will give higher vacuum than can be used. We get too little extra work at the expenditure of large quantities of cooling water. In the large cylinder we have the greatest friction and cooling losses; in the low pressure turbine we have the least as compared with the high pressure portion of the turbine.

The discs revolve in a nearly perfect vacuum, which makes the loss due to windage small, and if the steam friction loss is proportional to the specific weight of the steam, this loss is many times the smallest in the low pressure turbine.

The loss due to leakage through clearances is also proportional to the density and therefore much the largest in the high pressure turbine. In this the proportion of clearance to length of bucket may be as 0.1 in. to 1 in.; in the low pressure turbine this proportion is 0.1 in. to 5 in. average. The density of steam is about fifty times greater in the first stage than in the last, but it must also be remembered that leakages in the first stage take place only on 15 per cent of the circumference, whereas in the last stage the leakage takes place around the whole circumference. In the two high pressure cylinders the steam is working with a high efficiency because they can take care of the expansion, the friction and cooling losses are not large, due to the relative small dimensions and the increase in economy is nearly proportional to the rise in boiler pressure. This is not the case with turbines where leakage losses increase rapidly with higher pressure.

In order to obtain the most economical conditions, we will take a two cylinder compound reciprocating engine and feed it with a boiler pressure as high as has been found practical, say 225 lb. gauge and 200 degrees superheat (nearly all reciprocating engine-driven ocean liners use this pressure), and let this expand down to 14.7 lb. gauge in the engine; from there it is exhausted through a superheater, which also takes out the puffs, into a low pressure steam turbine, where it expands to 28 in. vacuum.

The flue gases will have a temperature of about 550 degrees F. for this high boiler pressure; therefore, the intermediate superheater can be put in the flue between the boiler and the smokestack like the economizer, the flues being run underneath the power house floor to facilitate short connections between reciprocating engine, superheater and turbine. Such a superheater would be much cheaper than an economizer for the simple reason that it has to stand only a few pounds pressure above or below the atmosphere.

Steam of 225 lb. gauge and 200 degrees superheat expanding adiabatically becomes saturated at 45 lb. absolute and at the end of its expansion we have only 93 per cent dry steam left. Expanding in a steam engine we would have less left, say 91 per cent, or 10 per cent less, which would be available for the superheater.

Take 2 lb. of coal as necessary to generate one kw.-hour. Burned with 200 per cent air supply we would have available in the flue gas: $2\,(23.2 + 1)\,450 \times 0.27 = 5880$ B.t.u. (Flue gas temperature 550 degrees, outside air 100 degrees). Take 15 lb. of steam as necessary to generate one kw.-hour. To superheat the exhaust from the engine 100 degrees would then require $15 \times 0.01 \times 0.55 \times 100 = 750$ B.t.u., 0.55 is average specific heat of superheated steam at this pressure. To re-evaporate 10 per cent, or 1.5 lb., at 14.7 lb. absolute would require $1.5\,(965 + 100 \times 0.55) = 1530$ B.t.u. Then the active flue gas temperature would be lowered $\frac{750 + 1530}{5880} = 38.8$ per cent. This would still leave a temperature difference between flue gases and outside air of $450 - \frac{450 \times 38.8}{100} = 276$ degrees for an

economizer to utilize, or for creating draft in the chimney.

The entropy diagram, Fig. 2, shows what work there is available in the stream. It is calculated as follows:

The entropy of water at 100 degrees (561 degrees absolute) $2.3 \log \frac{T}{493} = 2.3 \log \frac{561}{493} = 0.129$.

The entropy of water at its final temperature 397 degrees (225 lb. gauge) $2.3 \log \frac{(397 + 461)}{493} = 0.55$.

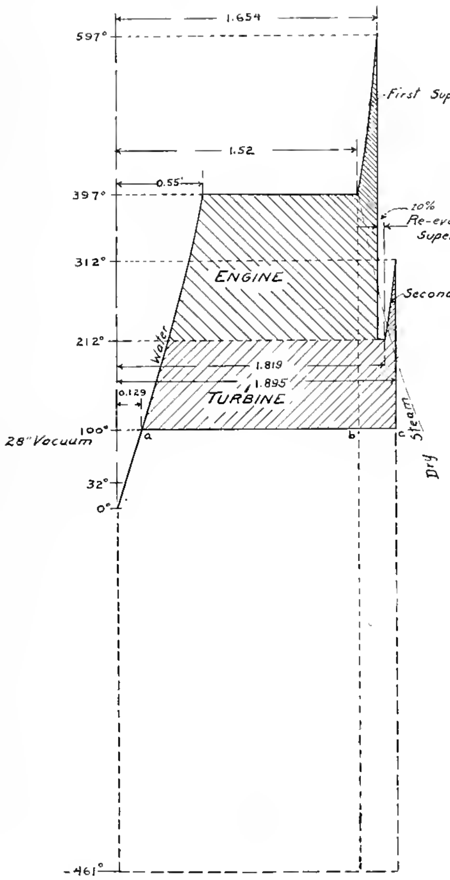


FIG. 2.

The entropy of dry saturated steam at 225 lb. gauge:

$$\phi = 2.3 \log \frac{T}{493} + \frac{r}{T} = 0.55 + \frac{833}{858} = 1.52.$$

r = latent heat of vaporization = 833 × T = 397 + 461 = 858 degrees.

The additional entropy of superheated steam 200 degrees superheat starting at 397 degrees.

$$\phi s_1 = 2.3 \times c \log. \frac{Ts}{T} = 2.3 \times 0.65 \log \frac{(858 + 200)}{858}$$

$= 0.134$.

c taken = 0.65 = specific heat of superheated steam starting at 397 degrees.

The total entropy of superheated steam 200 degrees superheat starting at 397 degrees.

$\phi + \phi s_1 = 1.52 + 0.134 = 1.654$.

Re-evaporation 10 per cent.

Total entropy of steam after re-evaporation =

$$1.654 + \frac{10}{100} \times 1.654 = 1.819.$$

The additional entropy of superheated steam 100 degrees superheat starting at 212 degrees.

$$\phi s_2 = 2.3 \times 0.55 \log \frac{Ts_2}{T_2} = 2.3 \times 0.55 \frac{\log 773}{673} =$$

0.076.

$Ts_2 = 673 + 100 = 773$.

$T_2 = 212 + 461 = 673$.

c taken = 0.55 = specific heat of superheated steam starting at 212 degrees.

Total entropy of steam superheated 100 degrees starting at 212 degrees = 1.819 + 0.076 = 1.895.

Total heat in 1 lb. of saturated steam at 225 lb.; gauge pressure by steam tables 1203 B.t.u.; heat in water at 100 degrees (28 in. vacuum) = 68 B.t.u.

Additional B.t.u. for superheating twice and re-evaporation = 0.65 × 200 + 0.55 × 100 + (1.819 — 1.654) 673 = 296 B.t.u

B.t.u. lost = area below the 100 degree line = 561 × (1.895 — 0.129) = 990 B.t.u.

$$\text{Efficiency} = \frac{1203 - 68 + 296 - 990}{1203 - 68 + 296} = \frac{441}{1431} =$$

31.0 per cent.

If we take the combined efficiency of engine and turbine at 75 per cent, we get the actual proportion between the work theoretical in the steam and the work taken off the shaft:

$$31 \times \frac{75}{100} = 23.2 \text{ per cent.}$$

A figure which is not realized in any plant today, but which it seems entirely possible to realize and which will be realized some day when fuel gets expensive enough to make the inconvenience of two different kinds of units a necessity.

Municipal electric plants, according to the census reports for 1907, number 1252, as compared with 815 in 1902 and as compared with 3602 commercial plants. Of these 150 were in the North Atlantic States; 158 in the South Atlantic; 727, North Central; 166, South Central; and 51, Western. Most of the municipal stations are in places of small population, nearly seven-eighths of the total number being located in places of less than 5000 population and less than 3 per cent in places having a population of 25,000 and over. The output, in kilowatt hours, of the municipal stations in 1907 was 289,462,788, as compared with 195,904,439 in 1902, an increase of 47.8 per cent. The commercial stations in this respect in 1907 increased 141.1 per cent.

THE HISTORY OF GAS-LIGHTING IN ALAMEDA COUNTY.

BY E. C. JONES.[1]

E. C. Jones.

Although San Francisco as early as 1854 was furnished with illuminating gas through the energies of Peter Donahue and others, it was not until 1867 that Oakland, then the second largest city in California, was supplied with this useful commodity. The overflow population of San Francisco had not up to that time discovered the attractions of suburban life, and transportation across San Francisco bay was, at best, hazardous. Oakland's wonderful climate, its miles of oak-covered lands, and its contiguity to San Francisco, began to prove inviting to the tired business men of the metropolis. By 1864 Oakland commenced to take on the aspect of metropolitanism. Attention was called to its great harbor possibilities existing in the estuary of San Antonio, which divides Oakland from Alameda. As a land-locked harbor it attracted, even at that time, the attention of the government, which commenced taking measures to improve it by erecting a training wall and deepening it by dredging. This work made available on each side of the estuary large tracts of hitherto submerged lands, and they became convenient sites for manufacturies. The originators and promoters of the Central Pacific Railroad, recognizing the value of this land as a terminus for the proposed transcontinental railroad, soon became a large owner of the property bordering on the bay on the west and the estuary on the south.

December 9th, 1865, a franchise was granted by the Oakland City Council to Joseph G. Eastland, at that time secretary of the San Francisco Gas-Light Company, and William W. Beggs, the San Francisco company's engineer. This franchise gave the privilege of laying gas mains in the city of Oakland, and fixed the gas rate at $7.50 a thousand cubic feet.

Following the granting of this franchise, the Oakland Gas-Light Company was incorporated June 12th, 1866, and the franchise was transferred to it by Joseph G. Eastland and William W. Beggs.

The first directors of this Oakland company were William W. Beggs, Joseph G. Eastland, and Anthony Chabot, a well-known citizen of Oakland, interested in the city's water supply. Anthony Chabot was elected the first president, and Joseph G. Eastland, the first secretary, of the company.

It was impossible at that time to locate a gas works upon the estuary lands. There obviously would have been the proper place for them, but the purchases made by the Central Pacific Railroad Company and the peculiar waterfront grants given to others by the city of Oakland rendered the estuary lands unavailable then. So a lot on the northeast corner of First and Washington streets, within a half block of the waterfront, was purchased as a site for the gas works, and Tyler Sabbaton, at that time one of the engineers of the San Francisco Gas-Light Company, was employed to prepare plans and specifications for the building of the gas works. Henry Adams was elected superintendent of these works. He was a resident of Sacramento. Later he was superintendent of the Napa Gas Works, and thereafter, until his death, was superintendent and manager of the Stockton Gas Company. When the Oakland company was reorganized in April of 1867, H. H. Haight, who had been Governor of the State of California, was elected president.

The first installation of the works consisted of a holder having a capacity of 5000 cubic feet, and one bench of three iron retorts housed in a brick building approximately 20x30 feet. The purifying house contained four purifiers, each 8x10x3 feet. It is recorded that in 1866, the first night that gas was turned on in the city of Oakland, the consumption for the night was 3000 cubic feet. In 1866 Van Leer Eastland succeeded Henry Adams as superintendent, and he continued in that office until his death, September 8th, 1894. In 1870 a second holder, having a capacity of 25,000 cubic feet, was erected. The maximum consumption had reached 20,000 cubic feet a day. From 1870 until 1874 very rapid progress was made in the laying of mains and the obtaining of customers. In 1873 it became necessary to enlarge not only the retort-house capacity but also the capacity of the purifiers and the storage tanks. Iron retorts had long since been discarded for those of clay. These clay retorts were imported from the East in benches of fives and were substituted for benches of threes.

Holder number three was built in the fall of 1873, and it had a capacity of 150,000 cubic feet. It remained in use until 1904, when it was discarder only by reason of the removal of the gas works from its original location.

The first dividend of the company was declared in January of 1874. From that day, until the consolidation with the California Gas and Electric Corporation in January of 1903, the Oakland company continuously paid dividends of twenty-five cents a share on the capital stock, with the exception of a period of eighteen months in 1884-5, when expenses of new construction caused the suspension of dividends.

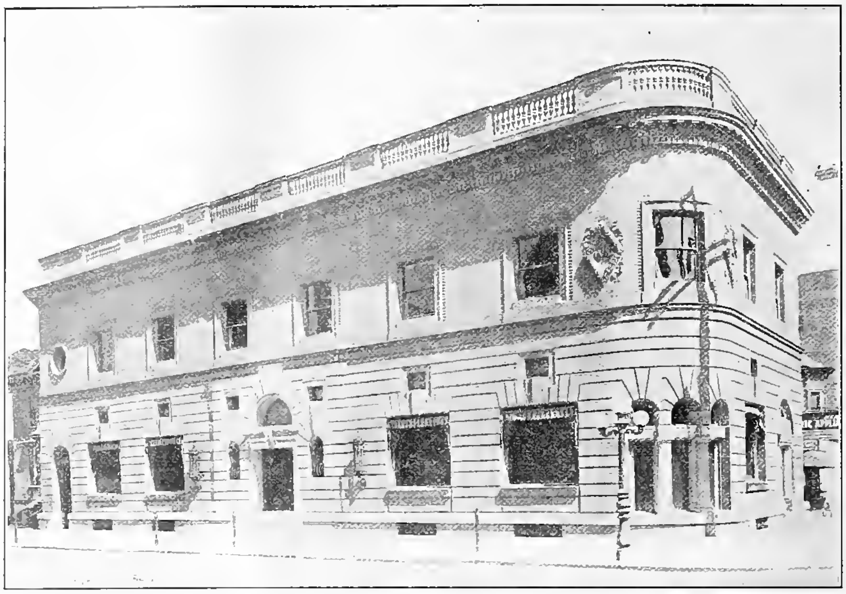
Having faith in the future growth of Oakland and foreseeing the needs of the enlargement of its plant, the company bought, in 1875, what is known as city block number 3, which is bounded by Jefferson, Grove, and Second streets. This was the site of the palatial home of Domingo Ghirardelli, the chocolate manufacturer. His was a place noted for a wonderful display of magnificent statuary, which he had collected during his frequent visits to Europe. In 1875, also, J. West Martin, a prominent Oaklander, was elected president to succeed ex-Governor Haight, who had died in the early part of that year.

In 1877 it became necessary largely to increase the capacity of the plant, and to use the old Ghirardelli home block. A bonded indebtedness was therefore incurred in the sum of $250,000 to provide money for the improvements. Holder number 4, having a capacity of 450,000 cubic feet, was erected, together with a purifying house having four purifiers, 20x24 feet each. The capacity limit of the plant as enlarged became fixed at 500,000 cubic feet. The output at that time was approximately 150,000 cubic feet a day. It was supposed then that the ultimate requirements of the plant had been reached, but the future determined otherwise.

During all of the ten years following the establish-

ment of the Oakland company, both the city of Alameda and the town of Berkeley, which had become the State University center, had been growing. Therefore in 1877 the directors of the Oakland company determined to extend the service of gas to both these neighboring communities. In that same year, anticipating future necessities, a part of the waterfront lying between Jefferson and Castro streets, was purchased.

During the first month of the operation of the Oakland company the records show that there were only twenty-three consumers connected with the mains. But in 1878, after eleven years' development, the total number had grown to 1801.



Office Building of Oakland Gas Light and Heat Company, Thirteenth and Clay Streets

In 1879 a gas holder was erected in Alameda. A pipe connection from the Oakland works at First and Washington streets was made across the estuary and into Alameda over the company's own drawbridge, which had been built on Webster street. The year 1879 marks the first installation in the United States of high-pressure gas service, as a pressure approximating eight pounds was carried upon the mains that ran from the works in Oakland over to the holder in Alameda. This high-pressure system was subsequently extended to include the distribution to customers, and was produced by means of a Connelly governor, which, until recently, continued in daily use.

The year 1879 also marks the introduction into California of gas stoves. Joseph G. Eastland, then the secretary of the Oakland company, had purchased, during a visit to Europe, a large invoice of Fletcher stoves. These stoves, after some difficulty and persuasive arguments, were put in various Oakland homes.

In 1880 the Lowe process was installed, Oakland being the second city in California to make use of this method of manufacturing gas. The oil for the manufacture of the gas was purchased from the Pacific Coast Oil Company at the rate of $2 a barrel.

In 1881 the town of Berkeley was first lighted by gas. But about that time the attention of the entire world had been called to the introduction of electric lighting. Foreseeing possible annihilation in competition with this new form of lighting, the Oakland company, with its usual progressive spirit, determined to secure such rights as it could to the ownership of electric service. In 1883 it secured from the Thomson-Houston Company exclusive rights to use in the cities of Oakland and Alameda and the town of Berkeley that company's apparatus, and in 1885 completed a building and installed two 25-arc machines.

In 1886 Oakland got her first cable-car line. Prior to that time transportation about the town had been by means of the now obsolete horse-car, which still survives as a California relic only in San Francisco and San Buenaventura.

In 1887, the Edison light having been perfected for general purposes, the Oakland company purchased the right to use the Westinghouse alternating system, and in January of the following year installed a 50-ampere machine having initial voltage of 1000.

In May of 1888 the company decided to erect an electric-lighting station on waterfront property at First and Grove streets. And in September of that year it purchased from the Westinghouse company two 1000-volt alternating-current generators of 50-ampere capacity. This was the first installation of incandescent electric-lighting in Oakland.

During 1889 Welsh anthracite coal was first used in the making of Oakland's water-gas. Then holder number 2 was erected in Alameda. In 1892 holder number 7, having a capacity of 700,000 cubic feet, was built on block number 3 by the Stacey Manufacturing Company.

The Oakland company, in July of 1892, moved into its new office building, then just completed, at Thirteenth and Clay streets.

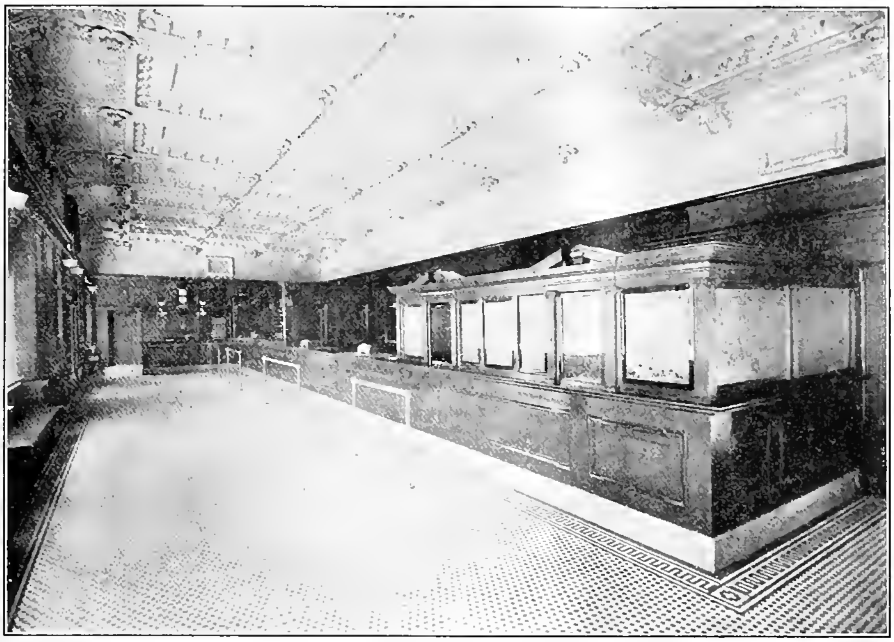
In 1893 the Station B electric-light works was erected. It contained two Fitchburg engines, each of 400 horsepower with boiler equipment, all installed by the Risdon Iron Works.

In December of 1894 the company imported bituminous coal from Japan for the manufacture of coal-gas. Earlier in the year a branch office had been established in Alameda.

During all the years following May of 1874, when he first entered the employ of the Oakland Gas-Light Company, John A. Britton was intimately associated with the success of the concern, occupying successively various positions of trust prior to his election to the secretaryship in August of 1883.

In September of 1894, following the death of Van Leer Eastland, who had for many years been superintendent of the company, John A. Britton was elected superintendent and engineer in addition to his old position as secretary.

In 1895 the Berkeley Electric-Lighting Company was purchased and absorbed. November 23d, 1895,



Interior of the Oakland Office.

Joseph G. Eastland, the secretary of the Oakland company, died, and January 2d, 1896, John W. Coleman, the president, also passed away.

In August of 1898 John A. Britton was elected president and engineer of the Oakland Gas Light and Heat Company.

During the spring and summer of 1902 the California Gas and Electric Corporation entered into a contract with the Oakland Gas Light and Heat Company to supply the Oakland company with oil-gas. Station B at First and Market streets was therefore selected for the manufacture of the oil-gas. This station had originally been erected as a gas works by the Equitable Gas Company in opposition to the Oakland Gas Light and Heat Company.

The first oil-gas ever manufactured in Oakland was made at Station B, September 1st, 1902. Oil-gas proved so successful that several additions had to be made to the plant. By September 11th, 1904, all of the gas supplied to the city of Oakland was what is known as crude-oil water-gas, and it was manufactured at Station B.

The gas business in Oakland increased normally until the earthquake of 1906. Then the enormous influx to Oakland of population from San Francisco created such a demand for gas that the gas delivery was increased from 563,000,000 cubic feet in 1905 to 970,000,000 cubic feet in 1906. This was at first considered a gain in business due to feverish conditions that would later shrink, but the increased send-out of gas was sustained and even augmented during the two subsequent years. Oakland reached its maximum output of gas December 21st, 1908, when that one day 6,835,000 cubic feet were furnished.

In 1907 the company constructed, at First and Grove streets, a 2,000,000-cubic-foot gas holder resting in a steel tank. During that same year additions were also made to the generating capacity of Station B to provide for the increased demand for gas.

Oakland is now provided with modern gas-making machinery and ample storage capacity to meet the demands of a city of its continued rapid growth.

GAS EXPERIENCE WANTED.

Leon B. Jones wants some experience, not for himself but for the members of the Pacific Coast Gas Association who will meet at Los Angeles on September 20, 21, 22, 1910. Mr. Jones is the editor of the experience department of the Association and promises to treat the name of the sender confidentially if so desired. Everybody is invited to send his contributions on gas experience to Mr. Jones at 445 Sutter Street, San Francisco.

OAKLAND'S GAS SYSTEM.[1]

BY KEMPSTER B. MILLER.

The gas for lighting, cooking and heating is supplied to the entire city of Oakland from a plant in the southern part of the city, near the bay shore. The Oakland gas plant was a pioneer in the employment of high-pressure mains throughout the system, for insuring a uniform pressure at the more remote points. The gas supplied is manufactured by a crude-oil-water process which seems to be peculiar to the Pacific Coast and more particularly to the territory surrounding San Francisco. This method of manufacture results in a rapid production of the gas, which in turn renders a large storage capacity unnecessary. This method of rapid production and small storage capacity would, unless properly safeguarded, be likely to result in a variable quality of gas from time to time, and this point was made the subject of particular investigation.

Numerous tests were made, extending over a period of approximately three weeks, to determine the illuminating and heating properties of this gas. In the illuminating tests a standard amyl-acetate lamp was used as a primary standard, this lamp having been calibrated for accuracy by the Bureau of Standards at Washington and at the Armour Institute of Chicago just before use. The photometer used was the standard Bunsen type using improved Lummer-Brodhun screen. The calorific measurements were made by means of a Junkers Calorimeter, which was carefully cleaned, overhauled and adjusted before and during the tests. All devices used in connection with these instruments were carefully checked for accuracy.

Illuminating Quality.

The results of tests made nearly every day for a period of about three weeks to determine the lighting

[1]Extract from Report on the Gas and Electrical Conditions of the City of Oakland.

qualities of the gas indicate that the gas had an average illuminating power of 21.9 candle power when burning at the rate of 5 cubic feet an hour and at atmospheric conditions corresponding to a temperature of 60 degrees Fahr. and a barometric pressure of 30 inches. The variation in candle power was from 24.6 c.p. as a maximum to 18.5 c.p. as a minimum, under the above conditions.

The times of making the tests on the different days ranged from 8:45 A. M. to 9:30 P. M. As the average candle power was 21.9 and as the minimum of all the tests was about 18.5 c.p., my conclusion is that the gas furnished during this period was satisfactory from the standpoint of its illuminating quality. As a basis of comparison I will refer to the following table as showing the candle power of the gas as required by the various State Commissions or by other bodies in the following cities:

New York City........22-c.p.	Buffalo, N. Y..........18-c.p.
District of Columbia...22-c.p.	Auburn, N. Y..........18-c.p.
Detroit................18-c.p.	Syracuse, N. Y.........18-c.p.
All Massachusetts cities.16-c.p.	Plattsburg, N. Y........18-c.p.

As the average candle power of the Oakland gas was 21.9, only one-tenth candle power below the requirement for New York City and the District of Columbia, and as the minimum for Oakland, 18.5, was above that of the other cities in this list, I am of the opinion that the gas measured in Oakland during this period is all that can reasonably be required in point of candle power.

Heating Quality.

Tests for determining the calorific or heat-giving qualities of the gas were likewise made nearly every day for about three weeks. The results of these tests show that the gas has an average calorific power of 613.8 B.t.u. per cubic foot at an atmospheric condition corresponding to a temperature of 60 degrees Fahr. and a barometric pressure of 30 inches.

During the tests the calorific power of the gas averaged from 642.6 B.t.u. as a maximum to 574.1 B.t.u. as a minimum. The change between these limits, like the candle power, was sometimes rather rapid, owing, no doubt, to the quick production and low storage capacity of the system.

As compared with these results for heating quality, I will quote from the rules of the Wisconsin Railway Commission, which commission exists for the purpose of regulating the methods employed and results obtained by public service corporations in that State:

"Rule 8:—The company, furnishing gas which within one mile radius from the distribution center gives a monthly average total heating value of not less than 600 B.t.u. with a minimum which shall not fall below 550 B.t.u., may be considered as giving adequate service as far as the heating value of the gas is concerned."

As the average calorific power of the Oakland gas, 613.8 B.t.u., is well above the average requirement (600 B.t.u.) of this commission, and as the minimum, 574.1 B.t.u., of the Oakland gas is well above the minithat the Oakland gas, as judged by this standard, is of good calorific power. Perhaps a requirement of 600 B.t.u. would come as near to representing the standard calorific requirement for good gas as can be given, and with this standard the Oakland gas compares favorably.

Throughout the tests no serious changes of pressure were noticed, the service being satisfactory in this respect. The process employed in the manufacture of this gas seems also to give a gas flame that is somewhat whiter in quality than the ordinary coal gas, which is a desirable feature. Furthermore, no criticism is to be made as to the objectionable products of combustion, as the gas seems to burn without objectionable smoke or soot. The gas, when escaping, has a pungent odor, amply sufficient as a safeguard against its escapement without detection.

THE ADVANTAGES OF SUPERHEATED STEAM.

BY E. H. FOSTER.

The advantages of superheating steam will be readily recognized, when it is considered that steam used for power plants is merely a vehicle for conveying heat to the steam engine. As such a vehicle, steam is at its best when it is free from water and also when it is performing the conveying act at the highest efficiency. Steam being a gas is used as such and the presence of water introduces a disturbing element. Provisions are made for handling the steam as a gas, but when water is present provision must also be made for handling water as a liquid. The elimination of water greatly simplifies the problem of designing and maintaining a steam power plant.

The increase of efficiency by superheating steam was discussed by Rankine in his work on the steam engine. By raising the temperature at which steam receives its heat efficiency is increased without producing a dangerous pressure. According to the law of efficiency of thermodynamic engines the heat transformed into mechanical energy bears the ratio to the whole heat received by the fluid as the range of temperature is to the absolute temperature at which the heat is received, as follows:

$$E = \frac{T_1 - T_2}{T_1 + 461.2}$$

Thus, the more heat supplied per unit of volume of steam to the engine, the more work can be obtained from the engine, and the increase of pressure having a practical limit this extra heat is to be obtained by superheating the steam.

The diminished density of the steam employed to do the work lessens the back pressure, or, as commonly expressed, improves the vacuum. This also applies to the air and vapor which are carried with the steam and further expanded by the increased heat and are consequently contracted to a much less volume, when chilled by striking the cooling surface of the condenser. Thus the air pump has less work to do.

The prevention of condensation of steam on entering the cylinder and of further condensation during

the early stages of expansion is obtained by superheating and without the use of steam jackets.

Steam jackets are wasteful and inefficient because they give contact only with the steam next to the walls of the cylinder, which necessitates carrying a high temperature in the jackets, in order to produce any effect on the steam which is in contact with the piston. Steam jackets are wasteful because of the heat which they impart to the exhaust steam and to the steam in the cylinder when the piston is near the end of the stroke and its pressure is low. At such times a transfer of heat takes place when the difference in temperature between the steam in the jacket and the steam in the cylinder is at its maximum point. This heat is all lost in the exhaust.

This is especially true of engines having a pause at the end of the stroke, such as direct acting pumps. We may, therefore, summarize the practical advantages of superheating as economy in boiler power, economy in engine power, economy in steam consumption, economy in fuel consumption, economy in sizes of pipes, valves, and fittings in the steam mains, better vacuum in condenser and longer life of the machinery.

The economy in boiler power is shown by the fact that superheated steam does from 10 to 20 per cent more work. This is brought about by the greater amount of heat contained in each pound of steam leaving the boiler and also by the efficiency of the steam in doing its work. It is not an infrequent occurrence in a plant containing five boilers to see one boiler put in reserve and the remaining four doing the work, after superheaters have been installed.

Economy in engine power has been frequently demonstrated by such tests as those made on the Rice & Sargent Corliss engines at the Milburne Mills in Philadelphia and at the American Sugar Refining Company in Brooklyn, also on the McIntosh & Seymour engines at the Edison Electric Light Works in Boston, which show that the economy of operation when steam is superheated is greatly improved, not only at normal load, but in much larger proportion when the engineer is running on partial load or on overload, the tendency being to equalize the water rate throughout a wide range of loads. This is also true in the case of steam turbines, as has been demonstrated by a test of the Westinghouse-Parsons machines at Hartford and other places and also on numerous Curtis turbines.

Economy in steam consumption has been frequently demonstrated in practice. Tests made at the Maryland Steel Company in their power plant, after installing the superheaters in connection with their Altmann & Taylor boilers show a saving of 12 per cent of the steam used by the plant on its regular work. The fuel used in this case is blast furnace gas. At the Wisconsin Steel Company in South Chicago the installation of superheaters in connection with their twenty Sterling boilers heated by blast furnace gas, resulted in the elimination entirely of the use of coal in the works, where it had been formerly necessary to supplement the steam generated by the blast furnace boilers from an auxiliary boiler house where coal was used.

A recent test of the vertical triple expansion water work engines built by the Camden Iron Works for Cincinnati show a saving of 8½ per cent fuel used by superheated steam of 100 degrees at the engines. In this case there were four engines tested, two with saturated and two with superheated steam. The test of each engine lasted 144 hours continuously. The average duty on saturated steam was 152,000 and on superheated steam 165,000 foot pounds, per hundred pounds of coal burnt under the boilers and superheaters.

At the Hyde Park plant of the American Sheet Steel Company, the reduction in the cost of fuel per ton of plate output was about 15 per cent, comparing the average of the four months after the superheaters were put in with the four corresponding months of the previous year. Most of these examples are taken from the experience of the past year or two. Numerous other important tests extending back several years have been a matter of record for several years past, and the number add the same conclusions with regard to the advantages of superheated steam.

Economy in fuel consumption has frequently been found after superheaters were put in to be greater than the saving in steam. This is doubtless due to the increased efficiency of certain boilers by adding the superheating surface. It may safely be estimated that where attached to the boilers superheaters will operate with an efficiency close to 100 per cent, the only loss being a slight additional friction of steam in passing through the superheater, which may be considered a negligible quantity. It is usually found that with coal at $3 per ton superheaters will save the cost of their installation in about two years.

In power plants it is desirable to have the auxiliaries operated with superheated steam, because in these more wasteful types of steam cylinders, the proportional saving is great. No difficulty need be anticipated from the use of steam at a temperature not exceeding 500 degrees F. in any type of steam engine with Corliss, slide, piston or gridiron valves.

Economy in the sizes of pipes, valves and fittings in the steam mains is due to the fact that the friction of superheated steam in pipe lines is much less than saturated steam and smaller pipes may be generally used.

Better vacuum in condenser is explained above, as demonstrated by practice at the Maryland Steel Company's plant, where fully 1 in. better vacuum is obtained on the central condensing apparatus when superheated steam is used.

Longer life of the machinery is obtained on engines, because keeping cylinders free from water improves lubrication, allowing the oil to keep on the surface and the risk from accidents and damage by the water in the cylinder is eliminated.

The engine is more readily put in service, as the warming up process is simplified and particularly in the case of steam turbines the wearing on the blades due to the presence of water in the steam is eliminated. Much difficulty has been experienced of late in reference to steam turbine blades being cut into deep at their base where they join the rotor, caused by the moisture carried with the steam. This has never occurred where superheated steam was used.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

(Continued.)

CHAPTER VIII.

RATES.

Birmingham (Alabama) Railway, Light & Power Co.

The consumer hereby agrees to pay the company, monthly, within ten days after presentation of bills, for said incandescent light service at the base rate of twelve cents per kilowatt hour, as measured by meter or meters to be furnished and installed by the company, subject to the following discounts:

LIGHTING RATES.

On monthly bills under	25 k.w.h.	10 %
" " " over	25 "	15 %
" " " "	150 "	20 %
" " " "	250 "	25 %
" " " "	400 "	30 %
" " " "	500 "	35 %
" " " "	1,000 "	37½%
" " " "	1,500 "	40 %
" " " "	2,000 "	42½%
" " " "	2,500 "	45 %
" " " "	3,000 "	47½%
" " " "	3,500 "	50 %

The consumer agrees to pay the company a net minimum monthly bill of ($........) ....Dollars as a readiness to serve charge.

POWER RATES.

Discount for Monthly Usage.

500—1000	k.w.h. per month	10% discount
1000—2000	" " "	12% "
2000—3000	" " "	14% "
3000—4000	" " "	16% "
4000—5000	" " "	18% "
Over 5000	" " "	20% "

In addition—

10 to 15	k.w.h. used per h.p. installed	4% discount
15 — 20	" " " " "	6% "
20 — 25	" " " " "	8% "
25 — 30	" " " " "	10% "
30 — 35	" " " " "	12% "
35 — 40	" " " " "	14% "
40 — 45	" " " " "	16% "
45 — 50	" " " " "	18% "
50 — 55	" " " " "	20% "
55 — 60	" " " " "	22% "
60 — 65	" " " " "	24% "
65 — 70	" " " " "	26% "
70 — 75	" " " " "	28% "
75 — 80	" " " " "	30% "
80 — 85	" " " " "	32% "
85 — 90	" " " " "	34% "
90 — 95	" " " " "	36% "
95 — 100	" " " " "	38% "
Over 100	" " " " "	40% "

10% additional for off peak service.

The San Francisco Gas & Electric Co., of San Francisco, Cal.

Lighting Rates.

All current delivered to the consumer shall be registered by a meter or meters installed and owned by the Company and the rate and minimum charge shall he as follows per meter:

per k.w.h.		k.w.h.
8 cents	if the monthly consumption be less than	79
7 "	" " " " from	80— 129
6½ "	" " " " "	130— 189
6 "	" " " " "	190— 244
5¾ "	" " " " "	245— 309
5½ "	" " " " "	310— 374
5¼ "	" " " " "	375— 449
5 "	" " "	450— 549
4¾ "	" " " " "	550— 674
4½ "	" " " " "	675— 849
4¼ "	" " " " "	850—1099
4 "	" " " " "	1100 or over

The consumer agrees to pay the company a net monthly minimum bill of $1.00 for each meter installed, provided the bill for current consumed at the above premises, does not equal or exceed the said sum of $1.00 per month.

The consumer further agrees to pay a minimum of $1.50 per month, for each horsepower in motor or motors installed, provided the bill for current consumed does not equal or exceed the said sum of $1.50 per horsepower per month.

Power Rates.

All current delivered to the Consumer shall be registered by a meter or meters installed and owned by the Company and the rate and minimum charge shall he as follows per meter:

Per 1000	If the monthly consumption	
9 cents	is above the minimum and	less than 2,000 w.h. per 16 c.p. lamp.
8.55 "	shall be from 2,000 to 3,000	w.h. per 16 c.p. lamp.
8.1 "	" " " 3,000 to 4,000	" " " " "
7.65 "	" " " 4,000 to 5,000	" " " " "
7.2 "	" " " 5,000 to 6,000	" " " " "
6.75 "	" " " 6,000 to 7,000	" " " " "
6.3 "	" " " 7,000 to 8,000	" " " " "
5.85 "	" " " 8,000 to 9,000	" " " " "
5.4 "	" " " 9,000 or over	" " " " "

Per k.w.h.	If the monthly consumption	
5.25 cents	shall be from 375 to 649	k.w.h.
5 "	" " " 650 to 924	"
4.75 "	" " " 925 to 1,199	"
4.50 "	" " " 1,200 to 1,474	"
4.25 "	" " " 1,475 to 1,749	"
4 "	" " " 1,750 or over	"

The consumer agrees to pay to the company a net monthly minimum bill of $1.00 for each meter installed, provided the bill for current consumed at the above premises does not equal or exceed the said sum of $1.00 per month.

The consumer further agrees to pay a minimum of $1.50 per month, for each horsepower or fraction thereof in motor or motors installed, provided the bill for current consumed does not equal or exceed the said sum of $1.50 per horsepower or fraction thereof per month.

From the data given above, a very good general idea can be gained of the fixing and application of lighting and power rates throughout the United States, though of course local conditions may cause a wide variation from the figures given.

(To be continued.)

CENTRAL STATION STATISTICS.

The commercial and municipal central electric light and power stations in the United States in 1907 numbered 4714; reported $1,096,913,622 as the cost of construction and equipment; earned $175,642,338, of which $169,614,691 was for electric service, including $125,755,114 for lighting; expended $106,205,149; employed 12,990 salaried officials and clerks, who were paid $11,733,787, and also 34,642 wage-earners, who received $23,686,537; operated 10,150 primary-power machines, with 4,032,365 horsepower capacity; had 12,173 dynamos, with a kilowatt capacity of 2,709,225; and their output, in kilowatt hours, was 5,862,276,737. Of the total number of lamps wired for service, there were: Arcs, 555,713; incandescent, 41,445,-997; and other varieties, 162,338.

Comparing the proportion of population with that for the number of stations, the proportion of stations was larger than that for population for the North Central and Western divisions and smaller for the North Atlantic, South Atlantic, and South Central divisions. One of the most pronounced features of the central-station industry is the large percentage showing for the Western division, which in 1907, having less than 5,000,000 population, as compared with the population of upward of 11,000,000 and 16,000,000 for the South Atlantic and South Central divisions, respectively, reported a greater primary horsepower and larger dynamo capacity and more incandescent lamps wired for service than the latter two divisions combined. In per capita showing, the North Atlantic division was second in rank, the North Central third, the South Atlantic fourth, and the South Central fifth.

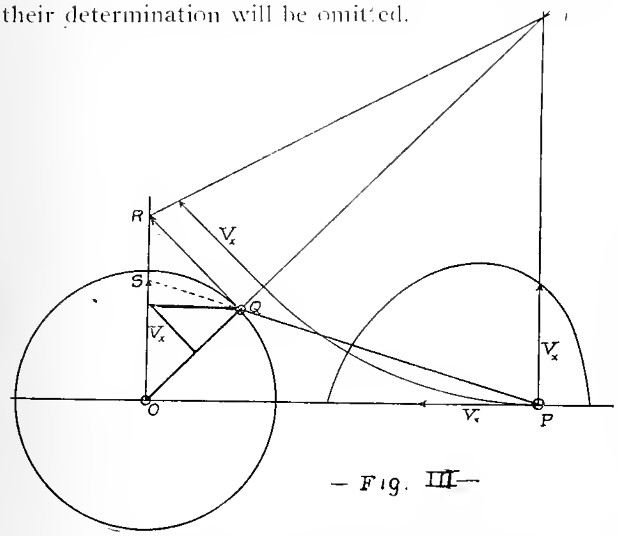
THE MECHANICS OF THE STEAM ENGINE.

(Continued.)

The component velocities of the crank-pin parallel with the vertical and horizontal axes may be found by constructing the parallelogram of forces with (QR) as the diagonal. (See figure III.)

The resultant and component velocities of any other point in the crank may be determined similarly, the resultant being parallel in direction with QR and proportional in amount to the distance of such point from the center O. That is, parallels to QR drawn between OR and OQ will give the direction and velocity of their points of intersection with OQ.

The velocities of intermediate points in the connecting rod may be readily determined by combining the angular velocity about (P) with the linear velocity of (P). Since these velocities are not of great interest to the practical engineer the construction necessary to their determination will be omitted.



— Fig. III—

The accelerations of the various parts of the engine chain are somewhat more difficult to understand than were the velocities.

Acceleration is the term adopted to convey the meaning of velocity change. Suppose a train to be moving at a speed of ten miles per hour. We say then, the velocity is constant and hence the change in velocity is zero, or, there is no acceleration.

Now suppose again that this train is not moving at constant speed, but is gaining speed such that, were its velocity measured one minute later than the above instant, it would be found to be fifteen miles per hour. The velocity change has been from ten miles per hour to fifteen miles per hour and this change has taken place in one minute. We say, therefore, that the acceleration has been five miles per hour during this minute, or five miles per hour per minute.

When considering the velocity of the crank-pin we learned that it was, for any instant, directed along the tangent to its orbit, or the circle it describes; and if the engine were running at a given number of revolutions per minute the magnitude of the velocity were constant. The direction, however, was changing uniformly. This velocity may be said, therefore, to have an angular acceleration.

Let us consider this acceleration. At the beginning of the head-end stroke, the velocity of the crank-pin in a vertical direction, or parallel with the Y axis, is constant and equal to the circumferential velocity of the pin. The horizontal component of the velocity, on the other hand, is zero at the end of the stroke. As the pin passes through the first quadrant to the position directly above the shaft, the component velocities vary; the vertical from its maximum to zero, and the horizontal from zero to the maximum, which value it assumes when the tangential velocity is horizontal as at the highest point in the circle.

The components of the acceleration have followed the velocity changes during this period. The vertical component at the beginning is zero. At the top of the circle it is a maximum and is downward, or negative, in direction. Between these two points the vertical component has increased gradually from zero to this maximum. Similarly the horizontal component of acceleration has decreased from its maximum at the end of the stroke to zero at the top of the circle.

Figure IV shows these component accelerations for a point Q in the quadrant, and their resultant is shown extending inward along the radius. It will be seen that the resultant acceleration is always directed toward the center of the circle.

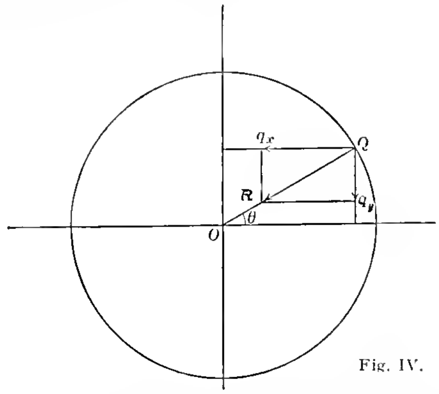


Fig. IV.

So long as the speed of rotation is constant these are the only accelerations with which the crank-pin is concerned. To accelerate any mass of material there is required a definite force proportional to the product of the mass and the acceleration. This is the centripetal force which the hub of a wheel exerts upon the spoke to hold the rim in its curved path.

The acceleration of other points in the crank is proportional to the distances of such points from the shaft center. These may be graphically drawn in a diagram similar to Figure III.

The vertical acceleration of the cross-head is zero.

The horizontal acceleration, however, is somewhat complex in its variations.

At the beginning of the head-end stroke, for instance, the velocity is zero, but as the crank-pin traverses the first few degrees of its path the cross-head begins to travel quickly and reaches a maximum velocity at a point where the connecting rod nears the tangency line of the crank orbit. During this interval the acceleration has decreased from a maximum at the beginning of the stroke where the velocity change was greatest, to zero at the point of maximum velocity (where the velocity change is for the instant zero).

The acceleration during this period follows the velocity changes beginning at a maximum and diminishing to zero at the point of greatest velocity.

CALIFORNIA OIL FUEL.

BY R. F. CHEVALIER.

Gas Analyses.

As already shown, the gases resulting from the combustion of oil are Carbon Dioxide (CO_2) Water (H_2O), Oxygen (O) and Nitrogen (N). If combustion is not perfect, combustible gases such as Hydrogen (H) and Carbon Monoxide (CO) will be present. In gases resulting from the combustion of oil CO rarely exists. The writer has never found more than ½ of 1% of this gas though dense clouds of smoke were issuing from the stack, owing to insufficient air supply.

By examination of the products of combustion we are able to ascertain the various constituents of the gases and determine whether there is a sufficient or over supply of air for combustion.

Following are some general remarks upon the analyses and measurement of gases taken from Hemple's Gas Analyses:

For the analysis itself various methods, corresponding to the nature of the gases, suggest themselves. The gases may be separated.

1. By successive absorption of the different constituents and the volumetric determination of each.
2. By absorption and subsequent determination by titration or weighing.
3. By combustion and the volumetric or gravimetric determination of the products.

Under all circumstances, however, the first operation is the measuring of the gas.

From the nature of a gas it is clear that its quantity can generally be better determined by measuring its volume than by ascertaining its weight. Hence one of the most important operations in gas analysis is the measurement of gases.

The volume of a gas is influenced by pressure, temperature and the tension of the liquid present.

By Boyle's law the density and the pressure of a gas are proportional to each other.

According to Gay-Lussac's law, gases expand 1/273 of their volume at 0° for each degree of temperature.

The tension of the confining or absorption liquid causes an increase of volume. This increase is dependent upon the temperature, is independent of the pressure, and varies with the chemical nature of the liquid in question.

To reduce a gas volume, measured in a moist condition, to the volume which it would occupy in a dry state at 0° C and 760 mm. pressure, the following formula is used: b is the observed barometric pressure, t the temperature, e the maximum tension of aqueous vapor at this temperature, and V the observed volume:

$$V_0 = V\frac{b - e}{760\ (1 + 0.00367\,t)}$$

In very exact work corrections should also be introduced for the expansion of the mercury and glass of the barometer.

Only those volumes can be directly compared with one another that have been reduced to equal pressure and temperature, the tension of the liquid being also allowed for.

Parallel gas measurement can be carried on under—

1. Varying pressure, varying temperature and varying volume.
2. Constant pressure, constant temperature and varying volume.
3. Constant temperature, varying pressure, and contant volume.
4. Constant pressure varying temperature, and varying volume.

In the first case the gas volumes found must be reduced to like temperature and pressure. In the second and third the resulting volumes can be directly compared, since density and pressure are directly proportional.

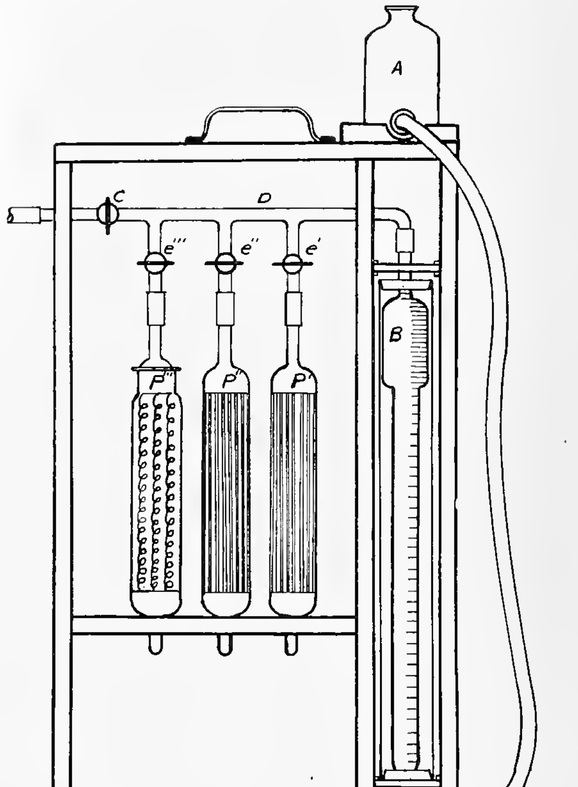


Fig. 1.

Volumetric method of gas analysis is the one in general use and for which there are various types of apparatus. For combustion gases the apparatus employed should be such that the degree of accuracy is within one per cent and at the same time should be portable, convenient and easy to manipulate. The apparatus of Orsat, a description of which follows, fulfills these conditions.

The apparatus (Fig. 1) consists of the leveling bottle A, the measuring burette B, which is water jacketed, the absorption pipettes P′ P″ P‴ and connecting tube D.

The absorption pipettes are in pairs connected at the bottom by a U tube (Fig. 2). The absorption side P contains small glass tubing to offer more absorption surface. Connections between the measuring

burette B and the pipettes P' P'' P''' are made by the glass stop cocks e' e'' e''', the pipettes and connecting tube D being joined by rubber tubing. At C is a three-way glass cock through which the sample of gas is drawn into B. Through the spindle of the cock, connection may be made to the atmosphere whereby air or gases in the apparatus may be discharged.

Preparation of Apparatus.

The glass stop cocks are removed and carefully cleaned and a small quantity of vaseline rubbed over them to prevent sticking.

The absorption pipettes are filled with their respective reagents, the liquid being equalized at about ⅝ of their capacity. The burette B is filled with pure water and the bottle A partially filled. The reagents

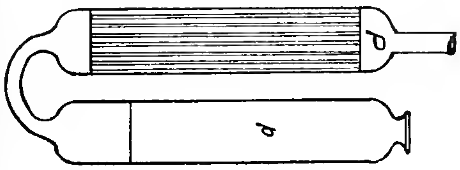


Fig. 2.

in the pipettes are then adjusted to a point on the stem of the connecting capillary tubes midway between the top of the rubber connections and the glass cocks c' e'' e'''. This is done as follows: all the cocks are closed with the exception of the one connecting the burette B to the pipette in which the reagent is to be adjusted.

Bottle A is lowered very slowly until the reagent is brought to the point above indicated and the cock is then closed. After adjusting the reagent in all the pipettes in the above manner, burette B and the tube connecting to bottle A are completely filled with water. This is accomplished by opening C to the atmosphere and allowing the air in B to be expelled, at the same time raising the leveling bottle A. A small quantity of water should remain in the latter. The water jacket surrounding B should then be filled with water. In adjusting the reagents, care should be exercised that none of the liquid or water enters the connecting capillary tube above the stop cocks, also that none of the reagent mixes with the water in B. The apparatus is now ready to receive the sample of gas.

(To be continued.)

TRANSFORMER CONNECTIONS.

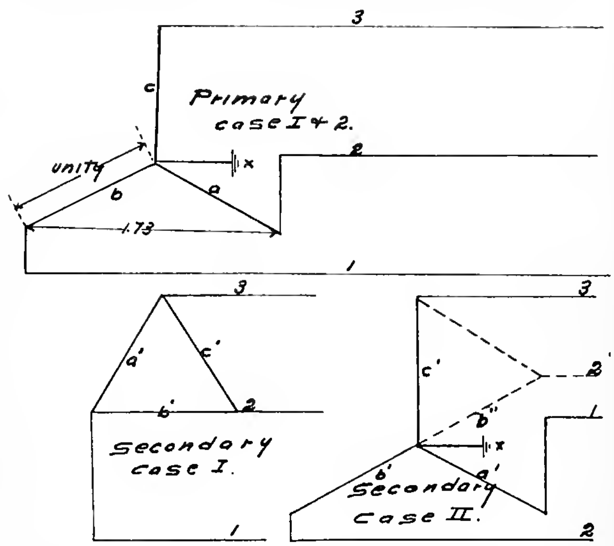
Question: Two banks of transformers, No. 1 and No. 2, operating on a "three-phase system Y connected on high side, Δ on low side (neutral grounded), one transformer in No. 1 bank breaks down. Now, No. 1 bank is out of commission as far as running in parallel with No. 2 is concerned. What I want to know is, can No. 1 be connected up in any way to run singly? CHAS. WINTERS.

Manton, Cal.

Answer: Regarding your question as to the operation of two transformers on a three-phase system to give three-phase on the secondary, under the hypothesis mentioned we would state as follows:

If one of a bank of three transformers (connected star on the primary and delta on the secondary) is disabled, it is possible to obtain three-phase current by simply disconnecting the injured transformer from the line on both high and low-tension windings. On the high-tension side the ground (X) will carry back to the power house transformers the unbalanced current load, while in the secondary winding a simple open delta condition will exist.

If the above transformers were connected delta delta, it is perfectly evident that taking out one transformer would not interrupt this service. If the transformers were star connected on high and low side, three-phase current cannot be obtained by disconnecting the third transformer, as it is obvious that when two phases are in service on the primary side that the same phase displacement would obtain in the secondary. It, therefore, would become necessary to reverse the connections of one of the phases on the secondary so that the phase displacement between it and the other leg of the open delta will be but 60 degrees.



By so doing, a true three-phase current would be obtained, but its value would be lower than the secondary voltage with three transformers in service, the new voltage being $\frac{1}{1.73}$. It would then be necessary to reconnect all the distributing transformers (which were operating on the secondary circuit) to delta.

By noting sketch it will be observed that if transformer a/a' were disconnected from circuit (with delta connected secondary), it would not change the operation of the system, otherwise than to cut down its capacity 33 per cent (see case 1). If, however, secondaries are connected star, it is obvious that three-phase cannot be obtained inasmuch as line 2 and 3 only are connected to the source of energy with neutral (X) grounded. If, however, the connections of b' are reversed its potential relation is changed to b'', which gives a true open delta condition; line 2 then becomes line 2', and by changing the connections of the distributing transformers two-thirds of the original capacity can be obtained (see case 2).

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Changes of advertising copy should reach this office *ten days in advance of date of issue*. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

Entered as second-class matter at the San Francisco Post Office as "The Electrical Journal," July 1895.
Entry changed to "The Journal of Electricity," September, 1895.
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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

CONTENTS

Fuel Economy

More power can be conserved by improving the economy of our developed steam plants than by withdrawing innumerable acres of undeveloped coal and oil lands or water-power sites. From ninety to ninety-five per cent of the energy in fuel is wasted. One-third is lost in smoke and one-half as exhaust steam. By saving even a part of this appalling loss we will benefit not only ourselves, but our posterity, who will blame us far more for our wasteful use of power than they will praise us for our conserving disuse. Economy in steam generation is dependent upon improving fuel combustion; saving in steam utilization may be effected by a low pressure turbine run with the exhaust steam.

Proper combustion is entirely a matter of air supply. Too little air causes carbon monoxide, which frees less than one-third as much heat as does carbon dioxide when it is formed. Too much air carries up the stack the heat that would otherwise be imparted to the water. The bad effects of excess air are usually under-estimated. If the owner of a power plant had to pay for his air as he does for his water, he would soon caution the fireman to use the minimum amount. But as his air costs nothing he continues blissfully ignorant of the fact that this free agent is regularly robbing the heat produced by burning at least one in every eight barrels of oil, until investigation of his fuel bill will show that there is nothing so expensive as what he gets for nothing.

Knowing the composition of a fuel it is easy to calculate the amount of air necessary for its combustion. Good practice allows an excess of fifty per cent. over this theoretical amount. Many plants, however, are using an excess of two hundred per cent. or more. Reducing this, means cutting down the fuel bill. There are three methods of determining how much air is being used: actual measurement with an anenometer, finding the heat loss by means of a pyrometer, or ascertaining its content in the flue gas, the last method being that most generally used. The percentage of carbon dioxide present is a reliable index of the amount of air passing through the furnace. Once that the correct percentage has been determined by an expert, it is merely necessary for the fireman to maintain it by adjusting his damper in accordance with the reading of some one of the mechanical carbon dioxide indicators that are on the market.

The low pressure steam turbine uses the energy in steam between exhaust pressure and that of a good vacuum, this energy not being used in the non-condensing reciprocating engine. As shown by Mr. L. R. Jorgensen in this issue, a combination of the turbine and the reciprocating engine effects great economy in steam utilization, which, together with the suggested saving in its generation, gives to the steam plant a much better rated efficiency. This is rational conservation.

PERSONALS.

F. A. Cressey, Jr., manager of the Modesto gas plant, is a San Francisco visitor.

John M. Klein, general manager of Mathias, Klein & Co., is visiting the Pacific Coast.

H. C. Keyes, president of the Natural Gas Company of Sacramento is at San Francisco.

Guy Sterling, an electrical engineer of Salt Lake City was a San Francisco visitor last week.

C. F. Conn, engineer with J. G. White & Co.'s San Francisco office, has gone to New York City.

Leon M. Hall of Hall, Demarest & Co., has returned from an inspection trip covering Merced and Virginia City.

J. W. White of the sales department of the Fort Wayne Electric Works, left last Tuesday for a trip to Nevada and Arizona.

F. A. Richards, who is in charge of the car and truck department of Pierson, Roeding & Co., left for Seattle last Tuesday.

A. M. Irwin, assistant to the treasurer of the Westinghouse Electric and Manufacturing Company, with headquarters at the San Francisco office, has returned from his summer vacation.

Delos A. Chappelle, who is interested in the hydroelectric company and other power enterprises in the interior of California, recently spent a day at San Francisco in consultation with his business associates.

Sidney Sprout, electrical engineer, has returned from a northern trip. Mr. Sprout, who has been located in the Crocker Building for some years, has just moved into more commodious offices—rooms 921 and 922.

O. A. Peterson, for several years with the General Electric Company at Lynn, Mass., and recently connected with the electrical department at the Bremerton Navy Yard, has arrived at San Francisco from Puget Sound.

Charles H. Gaunt, formerly superintendent of telegraph for the Santa Fe Railway, has been appointed general superintendent of the Western Union Telegraph Company, for California, Oregon, Washington, Idaho, Nevada, Utah, New Mexico, Arizona, and parts of Colorado and British Columbia, with headquarters at San Francisco.

S. F. T. Brock of Philadelphia recently arrived in San Francisco in connection with the reorganization of the Richmond Light & Power Company. Eastern capitalists have taken hold of this distributing concern which will serve Antioch, Martinez and several other towns besides Richmond. The capital stock has been increased from $300,000 to $2,500,000.

R. S. Masson of the Electric Operating & Construction Company, of New York, arrived last Saturday from the East and left for Prescott, Ariz., during the past week. His Arizona trip is connected with the taking over of the local electric lighting system in Prescott by the Arizona Power Company. The latter company has a hydroelectric plant, about forty miles from Prescott, which furnishes power for the Clark copper mines. The local steam plant has been purchased by the large concern which will engage in commercial lighting in future.

OBITUARY.

Charles S. Davidson, consulting electrical engineer with offices in San Francisco, died on the desert in Kern county, California, on June 17. Mr. Davidson was a graduate of the University of California in 1902. Two years ago he resigned as commercial agent for the Pacific Gas & Electric Company to take up consulting work which engaged his attention till his untimely death.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AND ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.

A joint meeting of the Los Angeles Section of American Institute of Electrical Engineers and the Association of Railway Telegraph Superintendents was held at Hotel Alexandria on Thursday, June 23, 1910, at 8 p. m. The wire crossing specification, which has been recommended for adoption by the Transmission Committee of the Railway Telegraph Superintendents, was the main subject discussed.

LOS ANGELES ELECTRICAL MEN'S PICNIC.

The second annual picnic of the electrical men of Los Angeles was held at Playa del Rey on June 11, 1910, with an estimated attendance of 550. The day was devoted chiefly to sports, the seven-inning baseball game between the Electrical Contractors vs. the Jobbers and the Manufacturers being won by the former with a score of 6 to 4. Other events were won as follows:

Throwing Baseball—1 B. C. Chase, 2 Mr. Wallace, 3 Mr. Towner.

Batting Baseball—1 Mr. Fleishman, 2 Mr. W. O. Spring, 3 Mr. R. Williams.

Running Broad Jump—1 Mr. Perry, 2 Mr. Fierce, 3 Mr. Hallet.

Standing Broad Jump—1 Mr. Rider, 2 Mr. Neir, 3 Mr. Hoag.

Race for Boys under 10 years—1 Harold Packman, 2 Fred Gilroy, 3 Joseph Warner.

Race for Girls under 10 years—1 Claudie Smith, 2 Margaret O'Connell, 3 Frances Porter.

Race for Boys under 16 years—1 Ernest Smith, 2 Harold Clark.

Race for Girls under 16 years—1 Verle George, 2 Bernice McCann, 3 Hallie Bowers.

Race for Fat Men—1 Mr. Frank R. Thomas, 2 Mr. T. M. Morris, 3 Mr. C. E. Warner.

Race for Stout Ladies—1 Mrs. Mina Hatlow, 2 Mrs. L. A. Duncan, 3 Mrs. Riley.

Dancing from 2 to 5. Free coffee and clam chowder were served at noon.

Potato Race for Ladies—1 Miss C. E. Allen, 2 Miss V. V. Venable, 3 Miss Callie Porter.

Egg and Spoon Race—1 Mrs. Ross, 2 Mrs. Warner, 3 Mrs. Porter.

Race for Heads of Commercial Houses—1 Mr. L. A. Duncan, 2 Mr. Bert Fanning, 3 Mr. Coffray.

Three-Legged Race—1 Harry George and George Larkey, 2 Bert Downer and Louis Kolb, 3 Eddie Weber and Robert Lanham.

Deep Sand Race for Ladies—1 Mrs. Gilroy, 2 Miss Black, 3 Miss Frank.

Sprinting Race for Real Sprinters—1 Mr. Spring, 2 Mr. Shaffer, 3 Mr. Berryman.

Tilting Race on Canal—1 Mr. Bowers and Mr. Warner, 2 Mr. Stetson and Mr. Hubbard, 3 Mr. Brown and Mr. Meek.

Swimming Race—1 Vernon Brown, 2 William Maddock, 3 G. Delman.

Bowling Tournament—1 Charles Sumner, 2 R. A. Thomas, 3 Cecil Meyer.

Bowling Highest Score—Van Runyan and Mr. Gross.

Chairman General Committee—Walter M. Fagan.

Finance Committee—C. B. Clapp and Harry Bowers.

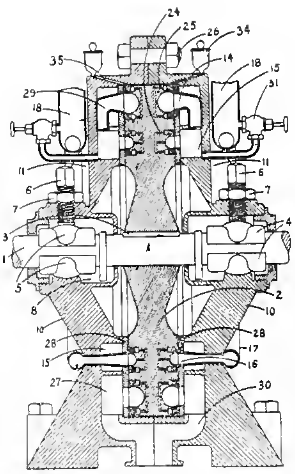
Sports Committee—George Cole (chairman), E. B. Clay, S. C. Purser, T. E. Berger, E. Woodbury and Van Runyan.

Ways and Means Committee—C. E. Warner (chairman), Mr. Baker, Mr. Woodward, Mr. Leavitt and Mr. Johnson.

Reception Committee—L. V. Benedict (chairman), C. Delman, Dick Northmore, Charles Coulter, Charles Hartung, N. W. Graham, Charles Carter and James Calkitt.

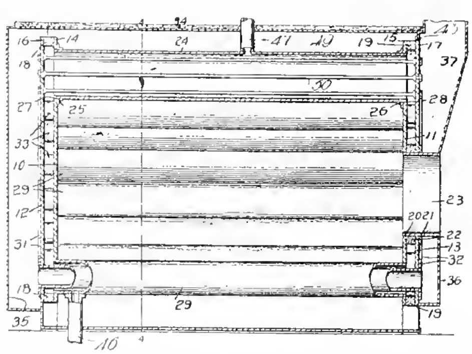
PATENTS

961,205. Reversible Steam-Turbine. Frank C. Beyerle, San Diego, Cal., assignor of one-half to R. M. Mobius, San Diego, Cal. In a device of the character described, the combination of a casing, of a power shaft journaled therein, of a rotative element mounted on the power shaft, of steam pockets formed within said rotative element, of annular and radial grooves, around said pockets of packing rings carried in said grooves, the said packing rings comprising annular concentric rings connected in pairs by short radial sections, and



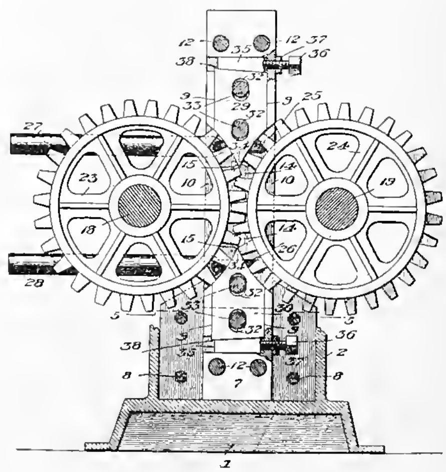
inner casings provided with inlet and exhaust ports, substantially as specified. In a device of the character described, the combination of a casing, of a power shaft journaled therein, of a rotative element mounted on the power shaft, of steam pockets formed within and upon opposite sides of the said rotative element, the impact surfaces of the pockets on one side facing in a direction opposite to those on the other side, of packing rings around said pockets, and inner casings provided with inlet and exhaust ports.

961,490. Steam-Generator. Robert J. Galbraith, Albany, Oregon. A steam generator comprising inner heads spaced apart and each provided with an upwardly directed extension, outer heads spaced from said inner heads and each provided with an upwardly directed extension, connecting means between each inner head and its extension and the adjacent



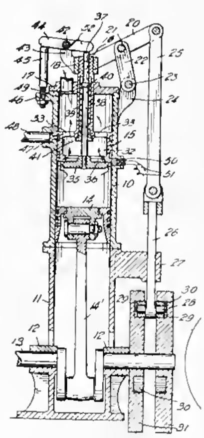
outer head and its extension and arranging the heads in pairs at each end of the generator, one of said spaced pairs having a fuel opening therethrough, a plurality of relatively small tubes connecting the inner heads near their peripheries and slightly apart with the tubes nearest the extensions spaced a greater distance apart, a plurality of flues connecting the outer heads and extending through the tubes which connect the inner heads, and a relatively large tube connecting the extension of the inner heads and above the large space between the upper tubes.

961,209. Fluid-Jet Motor. Clarence C. Cline, Oakland, Cal. In a motive fluid operated motor, the combination with rotary pistons having intermeshing vanes, of a casing in which the intermeshing vanes turn, means for directing opposing jets of the motive fluid to the intermeshing parts



of said pistons in a general transverse direction thereto, whereby friction on the pistons is neutralized, and an exhaust controlling valve movably mounted on the casing in position to regulate the exhaust at a point beyond the intermeshing vanes.

961,677. Internal-Combustion Engine. John W. Bradley, Seattle, Wash., assignor of one-half to Jacob E. Zickrick, Seattle, Wash. In a gas engine, a piston, a follower having movement independent of the piston, a by-pass extending



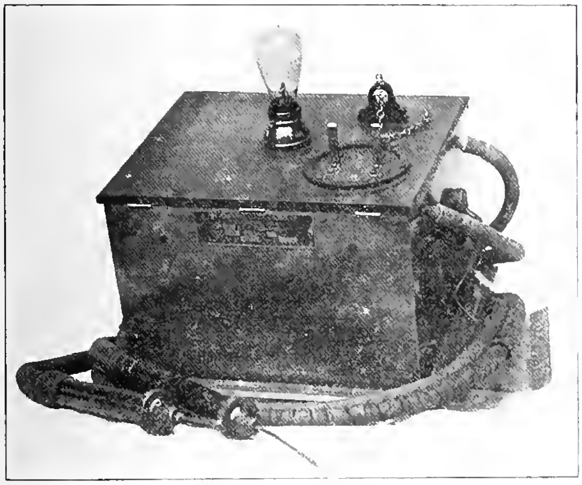
through said follower, a spring-closed valve for said by-pass, means operative from the engine shaft for reciprocating the follower, and means operative subsequent to the initial movement of the follower toward said piston for opening said valve for the escape of the spent gases through said by-pass.

INDUSTRIAL

A LOW TENSION PORTABLE TESTING OUTFIT

A small portable testing outfit, which the Westinghouse Electric and Manufacturing Company has recently developed, should appeal to the trade. There are continual calls about central stations, railway plants, car barns, repair shops, etc., for a portable testing device that will give an alternating voltage sufficiently high to test armature coils, meters, switches, and other details that are used in low tension systems and require an insulation test varying from 500 to 2000 volts. Such an outfit should be "fool-proof," as it must often be handled by men not familiar with high voltage; it should be semi-portable; it should afford a sufficient number of steps in the testing voltage; and last, but not least, it should be comparatively inexpensive.

The Westinghouse Company offers, for such service, a small bench-type, portable outfit, with a rating of .5-kw., which provides different testing voltages up to and including 2000 volts in 100-volt steps. It is designed for use on circuits of any frequency from 25 cycles up. Either a 110-volt or a 220-volt primary may be supplied. This capacity will be found sufficient for any normal testing up to 2000 volts. The 110-volt low-tension side may be connected to any source such as a lamp socket, walk receptacle, etc.



Low Tension Portable Testing Outfit.

The neat wooden box in which the testing transformer is mounted is approximately 9½ inches by 12½ inches by 14¾ inches, and the weight is only 60 pounds. Two cast iron handles are provided so that the box can be very conveniently carried about.

The testing voltage is varied by means of two small rheostat dials mounted within the box. To the contacts of the dial are brought the taps from the high-tension winding of the transformer. Any voltage from 100 to 2000 volts can be obtained in 100 volt steps.

The rheostat dials, as well as the high-tension binding posts, are mounted within the box. When the hinged cover is lifted to change the dial setting, the low-tension primary circuit is automatically opened, so that the box is absolutely "fool-proof" against any touching of the dials, binding posts, etc., while the transformer is excited. Two high-tension testing leads consisting of rubber covered cable, passing through rubber tubing, are brought out of the box and provided with heavily insulated terminals so that they may be handled with perfect safety by the tester.

A pilot lamp, connected across the low-tension primary circuit and mounted on top of the box, promptly indicates when the primary circuit is closed. A plug switch and fuse holder are provided in the primary to protect and control the circuit.

PRIZES AT LOS ANGELES ELECTRIC MEN'S PICNIC.

Prizes were donated as follows: American Elec. Novelty & Manufacturing Co., one thermos bottle; American Steel & Wire Co., cash, $5; Boston Woven Hose & Rubber Co., cash, $2; Cole Co., John R., cash, $10; Consolidated Electric Co., one 5-lb. iron; Cook Electric Co., one radiometer; Dodds-Caffray Co., cash, $5; Eccles & Smith, cash, $5; Electrical Supply Co., one desk lamp; Fairbanks-Morse Co., cash, $5; Forve-Pettibone Co., cash, $5; Foulkes-Gaylord Co., one disc heater; Gans Bros., one battery fan motor; General Electric Co., cash, $10; General Electric Co., one coffee percolator; General Electric Co., one baby milk warmer; Holabird- Reynolds Elec. Co., hot point utility set; Holabird-Reynolds Elec. Co., cash, $5; Home Tel. & Tel. Co., cash, $5; Hutchinson Co., W. G., one desk, portable; Ideal Elec. Co., two Hylo lamps; Illinois Electric Co., cash, $2.50; Industrial Elec. Co., cash, $5; Johns-Manville Co., cash, $5; Johns-Manville Co., one Electrotherm; Kellogg Switchboard & Supply Co., cash, $10; Kierulff & Co., B. F., cash, $5, one 100-watt tungsten; Leavitt-Bartholomew Co., one piano lamp, one brass jardinier; Lion Elec. Co., one desk, portable; Los Angeles Gas & Elec. Corporation, cash, $10; Meyberg Co., one desk, portable; Mission Mixture Co., one desk, portable; Murray, F. E., cash, $5; The National Conduit & Cable Co., cash, $5; Newberry-Bowers Elec, Co., cash, $5, one electric shaving mug; Pacific Light & Power Co., cash, $10; Pacific States Electric Co., cash, $5, one G. E. iron; Pacific Electric Heating Co., one automatic iron; Parmelee & Co., Z. L., one table lamp, one candlestick; Parmelee-Dohrmann Co., one vase; Pass & Seymour, cash, $5; Roebling's Sons Co., John A., cash, $5; Southern California Edison Co., cash, $10; Southern California Electric Co., one electric toaster; Standard Underground Cable Co., cash, $5; U. S. Long Distance Tel. & Tel. Co., cash, $5; U. S. Elec. Manufacturing Co., one sewing machine motor; Western Electric Co., six curling irons; Westinghouse Elec. & Mfg. Co., cash, $5, one electric stove toaster; Wilson Co., E. A., one desk, portable; Woodill & Hulse Electric Co., two nickel flash lights, cash, $5.

TRADE NOTES.

Hunt, Mirk & Co., have the contract to install additional turbo generators in the Phelan Building basement for the Equitable Light & Power Company.

The Decker Electric Company's bid of $46,000 was the lowest of a number submitted last week for a government contract in connection with the introduction of electric lighting at the Presidio of San Francisco. The construction of a pole line, sub-station and the wiring of several buildings were included in the specifications.

The Pelton Water Wheel Company is constructing for the Pacific Light and Power Company's Burrell power station, in the Kern River Canyon, a Pelton-Francis turbine wheel to develop 3600-h.p. under a head of 250 feet. The new wheel is direct connected to an alternator operating at 231 r.p.m. There are five generating units in operation at the plant.

NEWS NOTES

INCORPORATIONS.

VISALIA, CAL.—The Tulare County Power Company has been incorporated by J. J. Vosburg, C. H. Holly and H. H. Holly with a capital stock of $1,000,000.

SEATTLE, WASH.—The West Coast Power Company, capital $50,000, has been incorporated by J. E. Wickstrom, Central Building, Emory E. Hess and others.

SANTA ANA, CAL.—The Home Tract Water Company has been incorporated by W. H. Wells, G. F. Cochrane, R. C. Launders, J. G. Dunn and E. Crane, with a capital stock of $20,000.

SALEM, ORE.—The Southern Oregon Railway & Power Company has been incorporated by John R. Allen and others for $5,000,000 for the purpose of building electric railways, power plants, etc., in the Rogue river valley.

TRANSPORTATION.

BAKER CITY, ORE.—Anthony Mohr has been granted a franchise to construct a street railway here.

PERRIS, CAL.—Regarding the proposed electric railroad from Oak Cliff to Valle Vista, thence to Hemet, San Jacinto and Morento, J. S. Jackson, who asked, for the franchise, has temporarily withdrawn it.

OLYMPIA, WASH.—The $15,000 bonus required by the Olympia Light & Power Company for the extension of its system to the West Side has been raised, and it is expected that by September operations will be under way.

PORTLAND, ORE.—Final survey of the United Railway route through to Tillamook bay has been approved by President John F. Stevens, and contracting firms are now going over the proposed line for the purpose of preparing bids on construction.

RIVERSIDE, CAL.—The Riverside Portland Cement Company, which is extending the Crescent Railway line from its plant northward to Bloomington on the Southern Pacific, will secure rights of way for a further extension to Rialto. The road will be operated as a trolley line.

OAKLAND, CAL.—The Central Pacific, as a subsidiary of the S. P. Company, has filed application with the City Council for a franchise permitting the extension of its local ferry service through Melrose. The application asks that the company be allowed to extend its ferry service road from its present terminal to the Stanley road, the eastern boundary of the city.

LOS ANGELES, CAL.—The Public Welfare Committee has held a hearing on the petition of property owners to have a strip of land 200 feet in width on the south side of Agricultural Park condemned for park purposes. The property owners pointed out that one of the local railway companies contemplate using the land in question for a spur track and car barns, which will injure residential property. The committee took the matter under advisement.

OAKLAND, CAL.—The Oakland Traction Company has been censured by the jury sitting at the inquest held by County Coroner C. L. Tisdale to inquire into the causes of the wreck at Leona Heights on Decoration Day. The gist of the verdict rendered is to the effect that the company and the motorman and the conductor of car No. 251 were equally to blame for the disaster which cost the lives of five persons. The conductor was censured for neglecting to inspect the registry book, and the company for running crowded cars on a single track, without a block system.

SAN FRANCISCO, CAL.—Morrison & Brobeck, the attorneys for Horace G. Platt, the plaintiff in the Geary street municipal railroad case, have filed their reply brief in the Supreme Court, where the case is now pending on appeal from the decision in favor of the city. The point on which the appellant appears to rely in this reply brief is the claim that in the section of the city charter relating to the acquisition of a street railroad property by the city there is a clause permitting the sale or lease of the property by the city after the road comes into possession of the munipality. The argument is made that this clause is unconstitutional, and that, therefore, the whole section is void.

FRESNO, CAL.—At a conference of business men, who are interested in the proposed electric railroad between Fresno and Monterey, it was decided to incorporate a company with a capitalization of $4,000,000 and to begin construction work within 60 days. It is hoped to complete the road as far as Coalinga in nine months and connect Fresno with tidewater in two years. Those in attendance at the session were Judge Kerr and A. P. May of Coalinga, A. G. Metz and H. N. O'Bryan of Monterey; A. B. Harris and A. B. Weller, attorneys of San Francisco, and George Chalmers and E. R. Shaw, railroad men of San Francisco. Among the Fresnoans interested is Dr. W. T. Burks. From the oil fields of Coalinga the road will pass through Pinoche Pass, touching Tres Pinos, Hollister, Salinas and Monterey. From Coalinga the survey leads directly across the plains to this city.

TRANSMISSION.

SPOKANE, WASH.—The Washington Water Power Company plans to overhaul and improve its network of overhead wires.

ST. MARIES, IDAHO.—The St. Maries Light & Power Company is preparing to build a $35,000 power plant on the St. Maries river.

PRINCETON, CAL.—Preparations are being made by the Northern California Power Company to extend its lines from Hamilton City to Jacinto, where the power is to be used for the operation of irrigating pumps.

NEWPORT, WASH.—The Washington Water Power Company will build a high tension line from its power plant at Little Falls on the Spokane river, a distance of 70 miles, at a cost of $150,000. This is for the purpose of furnishing light and power to various towns along the line.

BERKELEY, CAL.—The Berkeley City Council has officially acknowledged the petition of the Great Western Power Company, which seeks a franchise in the city for the operation of its plant and the sale of electric current, by setting Tuesday, July 19th, as the day on which the franchise shall be disposed of to the highest bidder as provided by the new city charter. In granting the franchise the Council will reserve the right to specify the rates, and to name the districts in which wires shall be placed underground.

OROVILLE, CAL.—The Great Western Power Company has begun work on the dam across the Feather river, above the head of the tunnel, in the Big Bend, 30 miles from this city. Four hundred men will be put at work at once, and this force will be increased to 1200. The power company had planned to begin work on the dam early this spring but, owing to the difficulty of finding good foundations, the commencement of operations was delayed. There was no difficulty in finding a good foundation in the river, but the trouble lay in the banks, as the foundation was not suitable for the permanency of a dam 150 feet high.